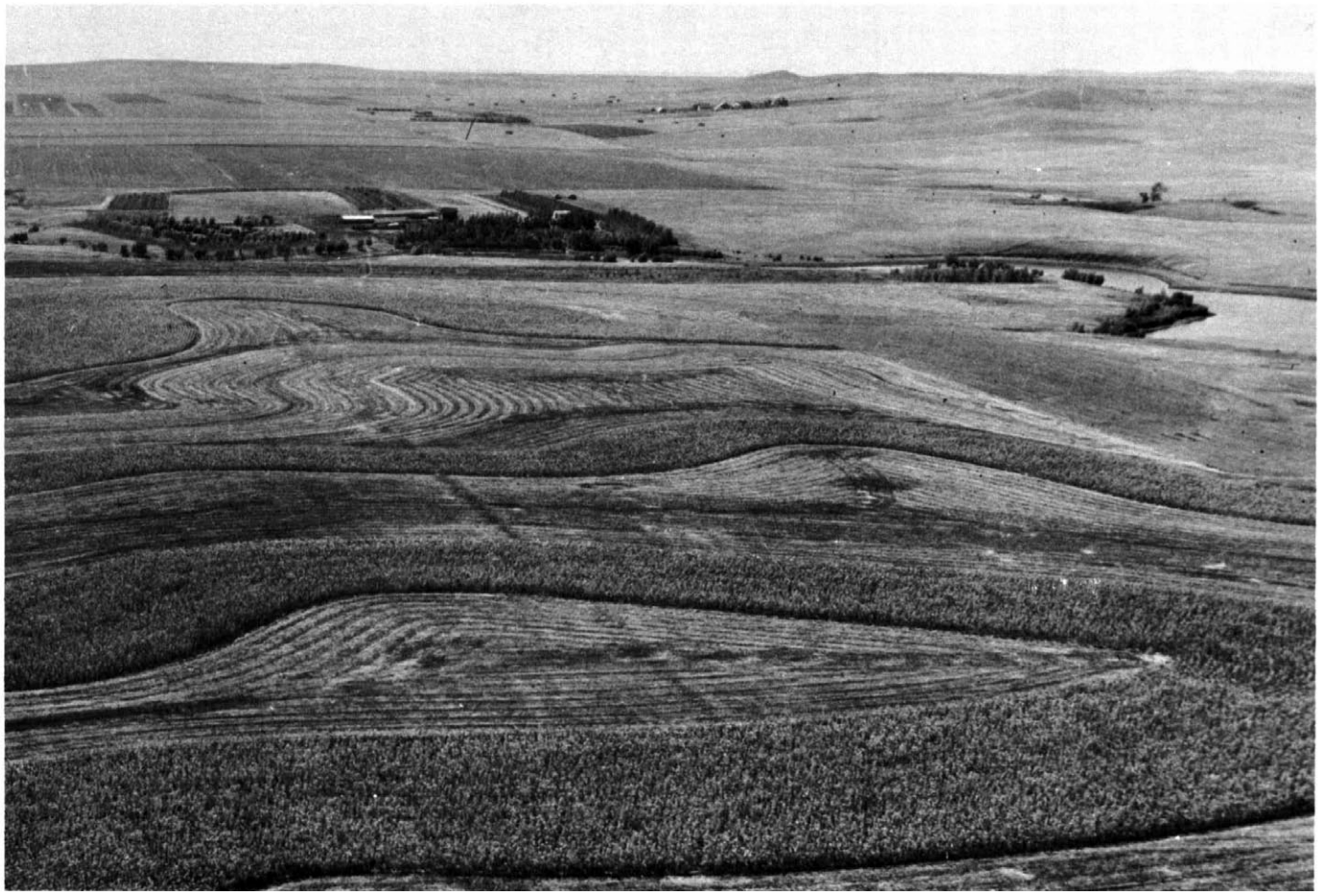
SOIL SURVEY OF

Sully County, South Dakota



United States Department of Agriculture
Soil Conservation Service
In cooperation with
South Dakota Agricultural Experiment Station

Issued March 1975

Major fieldwork for this soil survey was done in the period 1960–66. Soil names and descriptions were approved in 1967. Unless otherwise indicated, statements in the publication refer to conditions in the county at the time the survey was in progress. This survey was made cooperatively by the Soil Conservation Service and the South Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Sully County Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Sully County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the pasture group, range site, and windbreak group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units, the pasture groups, the range sites, and the windbreak groups.

Foresters and others can refer to the section "Use of the Soils for Windbreaks," where the soils of the county are grouped according to their suitability for trees and shrubs in windbreaks.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Use of the Soils for Wildlife."

Ranchers and others can find, under "Use of the Soils as Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Engineers, builders, and community planners can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Sully County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "General Nature of the County."

Cover: **Contour stripcropping on Agar silt loam, 2 to 5 percent slopes.**

Contents

SOIL SURVEY OF SULLY COUNTY, SOUTH DAKOTA

BY GARY J. DELANEY, SOIL CONSERVATION SERVICE[1]

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

SULLY COUNTY is in the central part of South Dakota (fig. 1) on the east bank of Lake Oahe. It covers a total area of 688,640 acres, including the water areas of Lake Oahe. Onida is the county seat.

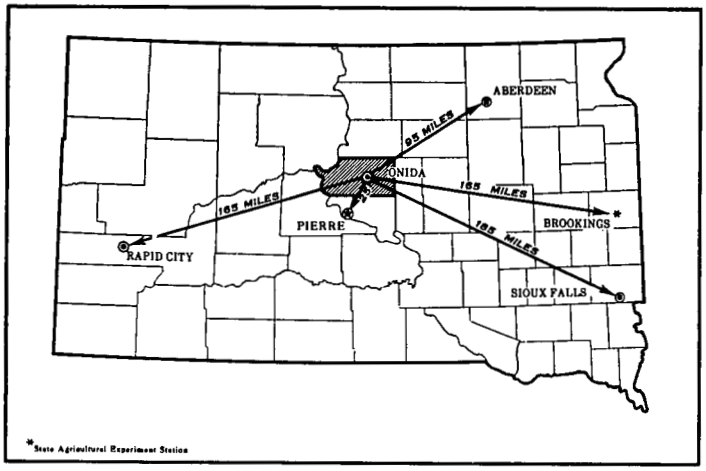


Figure 1.—**Location of Sully County in South Dakota.**

Surface relief in much of the county is nearly level to gently sloping or gently undulating, but rolling to steep soils are adjacent to Lake Oahe and along the two principal streams, Okobojo and North Medicine Knoll Creeks (fig. 2). Elevation above mean sea level ranges from about 1,600 feet on the shore of Lake Oahe to about 2,100 feet on Sully Buttes.

Most of the county is drained by the two principal streams that flow intermittently from northeast to southwest to the Missouri River system of impounded reservoirs. The main drainage systems are fairly well defined, but the flow in the tributary drainageways is sluggish and in places terminates in lakes, intermittent ponds, and marshes.

The climate is subhumid, and summers are hot and winters cold. Native grass made up the original vegetation, but a few trees and shrubs are on the bottom lands and in the heads of drainageways.

Farming is the principal source of income in the county. Growing wheat and raising livestock are the main farm enterprises. Cattle ranching is the main enterprise in the western part of the county. About 48 percent of the county is cultivated. Wheat, corn, oats, and alfalfa are the main crops.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Sully County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Agar and DeGrey, for example, are the names of two soils series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Lowry silt loam, 0 to 2 percent slopes, is one of several phases within the Lowry series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries ac-

[1] Others who contributed to the soil survey are ADRIAN A. PARMETER, ROBERT F. SPRINGER, and MILES W. SMALLEY, Soil Conservation Service.

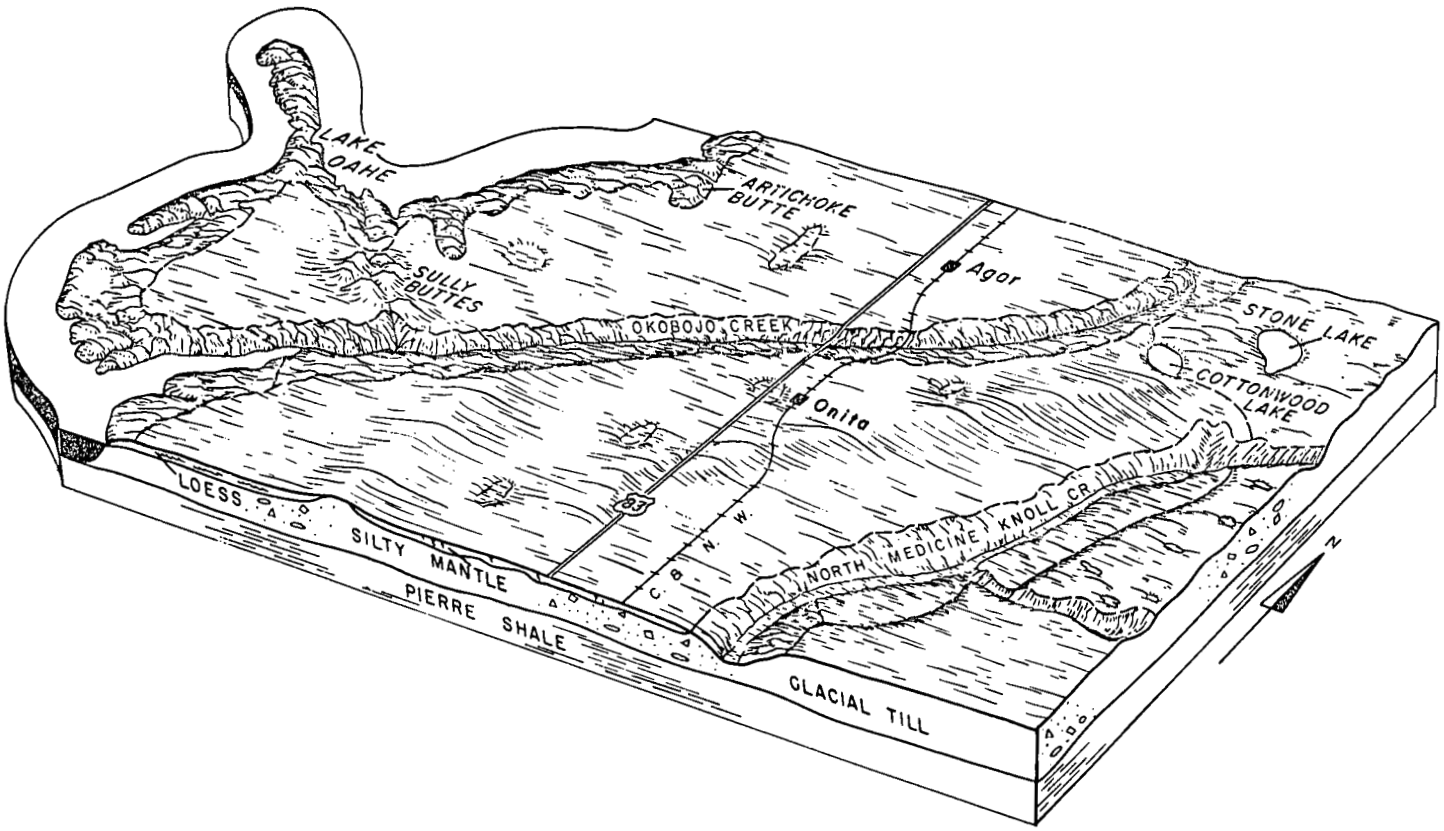


Figure 2.—**Surface features of Sully County.**

curately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Sully County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Agar-DeGrey silt loams, 0 to 2 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. Raber and Glenham loams, 3 to 6 percent slopes, is an undifferentiated soil group in this county.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Clayey alluvial land is a land type in this county.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or to a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Sully County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey have been grouped into three general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations in each group are described in the following pages. The terms for texture used in the title for several of the associations apply to the texture of the surface layer. For example, in the title of association 1, the word "clayey" refers to the texture of the surface layer.

Clayey Soils on Missouri River Breaks

In this group are well-drained clayey soils over shale. The soils on most of the slopes are hilly to steep. Runoff is medium to rapid, and the risk of erosion is high. Most areas in this group are in native grass used for grazing.

1. Dupree association

Shallow, sloping to steep, well-drained, clayey soils over shale; on uplands

This association consists of Missouri River breaks along Lake Oahe. Slopes are mostly hilly to steep except for narrow benches and foot slopes that border the lake. Many short drainageways and deep, long, narrow draws and canyons are in this association (fig. 3). Steep-sided buttes are also included. Much of the area is underlain at a shallow depth by clay shale, but scattered throughout the association are ridges and buttes that have thin mantles of glacial till, gravelly outwash, or silty loess. Glacial stones and boulders are on the buttes and some of the ridges.

This association makes up about 6 percent of the land area of the county. The hilly to steep Dupree soils make up about 30 percent of the land area, and minor soils and land types make up the remaining 70 percent.

Dupree soils are shallow over soft clay shale. They have a thin surface layer of gray clay and a subsoil of olive-gray clay that is very hard when dry and sticky and plastic when wet. The underlying material is light olive-gray clay over light olive-gray and gray shale at a depth of 16 inches.

Opal soils are the most common of the minor soils. They are on the mid and lower parts of the landscapes with Dupree soils. Less extensive in the association are Betts, Gettys, and Oko soils in the upper part of the breaks and buttes that are mantled with glacial till; Lowry soils on low terraces along Lake Oahe; Hurley and Promise soils on foot slopes; Sully soils on loess-capped ridges; and Talmo soils on the upper parts of the landscape that are mantled with gravelly outwash. Also in the association are the land types Rough broken land in some of the hilly to steep areas; Saline and alkali land on foot slopes and bottoms of draws; and Shale land in eroded areas and on almost vertical banks and escarpments.

Steepness of the soils and shallowness of the clayey Dupree soils limit the use of most of the association to grazing. Runoff is rapid, and gullies are in many of the drainageways and draws. Control of erosion and the conservation of moisture are the main concerns of management. Soils of this association have severe limitations for engineering uses.

Silty Soils on Loess-Covered Uplands

The Agar-Onita association is in this group. Slopes are long and smooth, and most of them are nearly level and gently sloping. The major soils are high in fertility and available water capacity. Risks of water erosion and soil blowing are slight to moderate. About 75 percent of the area is cultivated.

2. Agar-Onita association

Deep, nearly level to sloping, well-drained, silty soils formed in loess and deep, moderately well drained, silty soils formed in alluvium; on uplands

This association is a loess-mantled plain immediately above the Missouri River breaks. Most of the association is north and west of Okobojo Creek. Slopes are long and smooth, and most of the soils are nearly level and gently sloping. Small, closed depressions and intermittent ponds or lakes are scattered throughout the association, but otherwise the drainage pattern is well defined.

This association makes up about 33 percent of the county. About 60 percent is Agar soils, 20 percent is Onita soils, and 20 percent is minor soils.

The well-drained Agar soils have a dark-gray silt loam surface layer. The subsoil is silty clay loam and ranges from dark gray in the upper part to grayish brown in the lower part. The underlying material is calcareous, light brownish-gray silty clay loam and silt loam.

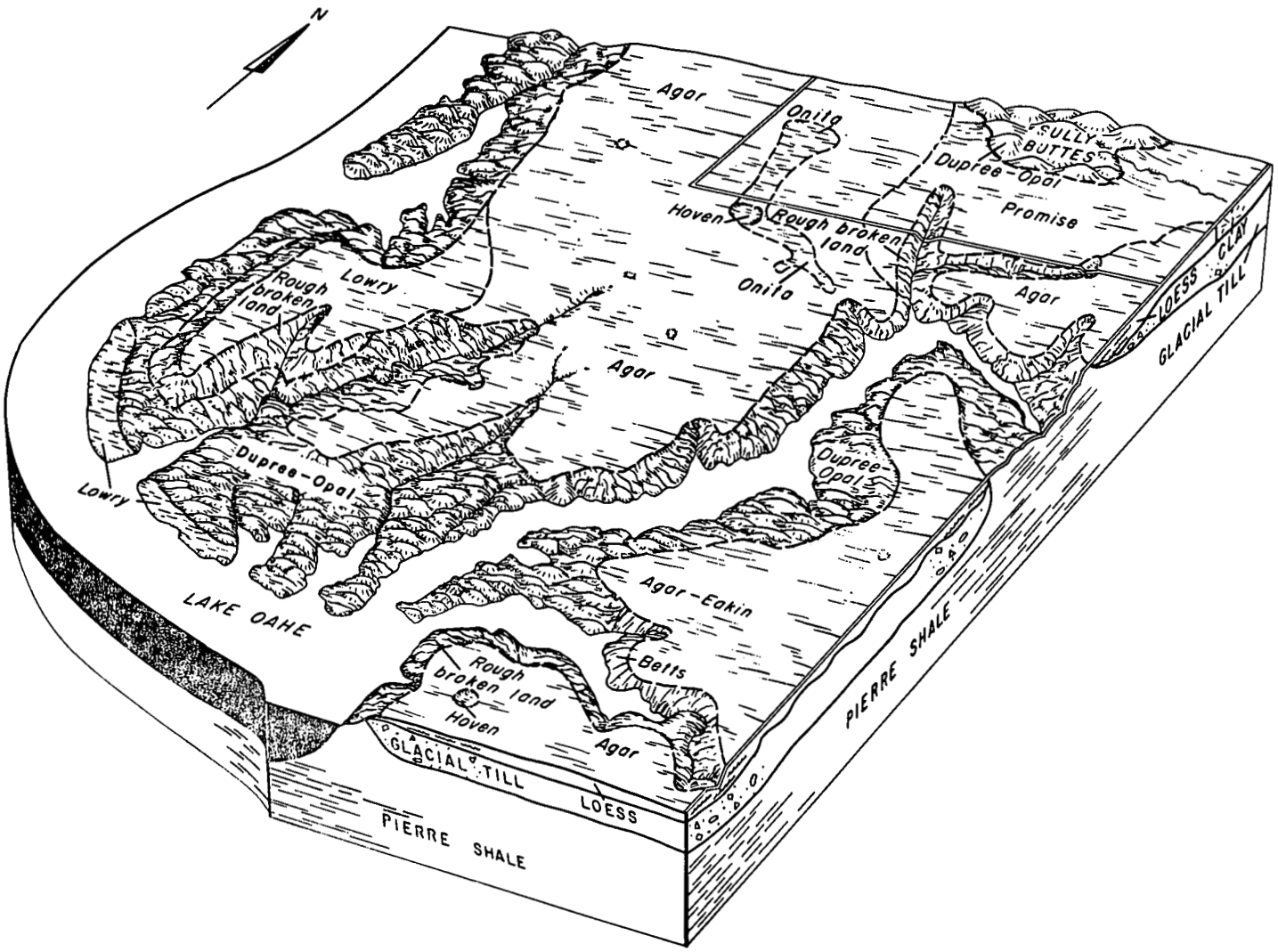


Figure 3.—**Relative position of major soils in the southwestern part of Sully County.**

The moderately well drained Onita soils are in swales and slight depressions. They have a thick surface layer of dark-gray silt loam. The thick subsoil is dark grayish-brown silty clay loam and silty clay in the upper part and grayish-brown silty clay loam in the lower part. The underlying material is calcareous, light yellowish-brown silty clay loam.

Less extensive in the association are DeGrey and Walke soils in some swales and slightly depressional areas; Eakin soils on the upper part of some rises; Hoven soils in closed depressions; nearly level to gently sloping Hurley, Opal, and Promise soils on foot slopes below Sully Buttes; and Lowry soils in some areas adjacent to the Missouri River breaks.

Runoff is slow to medium. The major soils have moderate to moderately slow permeability, have high available water capacity, and are high in fertility. Conservation of moisture and the control of water erosion and soil blowing are the main concerns in management.

About 75 percent of this association is cultivated. Corn, small grain, and alfalfa are the main crops. The major soils are well suited to all crops commonly grown in the county. The long, smooth slopes are well suited to terraces, grassed waterways, and similar structures for controlling erosion. The Agar soils are better suited to irrigation than other soils of this association. Limitations to many engineering uses are slight to moderate.

Silty and Loamy Soils Formed in Glacial Drift, Glacial Till, and Glacial Outwash Materials, Mainly on Uplands and Terraces

Most of the soils in this group formed in glacial deposits. Slopes are medium to short and many of them are irregular. Most of the soils are nearly level to undulating, but rolling to hilly soils are scattered throughout this group. Glacial stones and cobblestones are common on ridges and knolls except in the Highmore-Eakin association. The risks of water erosion and soil blowing are slight to severe. About 50 percent of the acreage is cultivated, and much of this is concentrated in the Highmore-Eakin association.

3. *Betts-Durrstein association*

Deep, undulating to hilly, excessively drained, loamy soils formed in glacial till and deep, level, poorly drained claypan soils formed in alluvium; on uplands and bottom lands

This association consists of bottom lands and the sides of valleys along North Medicine Knoll and Okobojo Creeks (fig. 4). Slopes of the undulating to hilly valley sides are short, convex, and irregular.

This association makes up about 5 percent of the county. About 40 percent of it is Betts soils, about 15 percent is Durrstein soils, and 45 percent is minor soils.

The excessively drained Betts soils are on the sides of valleys. They have a thin surface layer of dark-gray loam and a thin subsoil of calcareous, grayish-brown light clay loam. The underlying material is calcareous, light brownish-gray and light yellowish-brown clay loam. In places few to many glacial stones and boulders are on the surface.

The poorly drained Durrstein soils are on bottom lands that have a fluctuating water table. They have a thin surface layer of gray silt loam over a claypan subsoil. The subsoil is dark-gray clay in the upper part and grayish-brown silty clay in the lower part. The underlying material is calcareous, gray and olive-gray silty clay. Spots and streaks of salts are between depths of 11 and 42 inches.

Less extensive in the association are Egas soils and Saline and alkali land on the bottom lands with Durrstein soils; Glenham and Java soils on the less steep parts of the valley sides; Oahe and Talmo soils near pockets of sand and gravel on the valley sides; DeGrey and Onita soils on foot slopes; and Ree soils on narrow, low terraces in the valleys.

Runoff is rapid on the sides of the valleys and slow to very slow on the poorly drained bottom lands. Controlling erosion on the hillsides and alleviating wetness and salinity of the bottom lands are the main concerns in management.

Most of this association is in native grass used for grazing and hay. Scattered areas are in cropland. Alfalfa is the main crop. Limitations are moderate to severe for many engineering uses.

4. *Oko association*

Deep, nearly level to hilly, well-drained, loamy soils formed in glacial till; on uplands

This association is along Okobojo Creek and consists of slopes on the western and northern sides of the valley (see fig. 4). Slopes are mostly undulating to hilly. Few to many glacial stones and boulders are scattered on the surface in much of the area.

This association makes up about 3 percent of the county. Oko soils make up about 50 percent of the association and minor soils the remaining 50 percent.

Oko soils have a thin surface layer of dark grayish-brown clay loam and a subsoil of grayish-brown clay loam in the upper 4 inches. The rest of the subsoil is

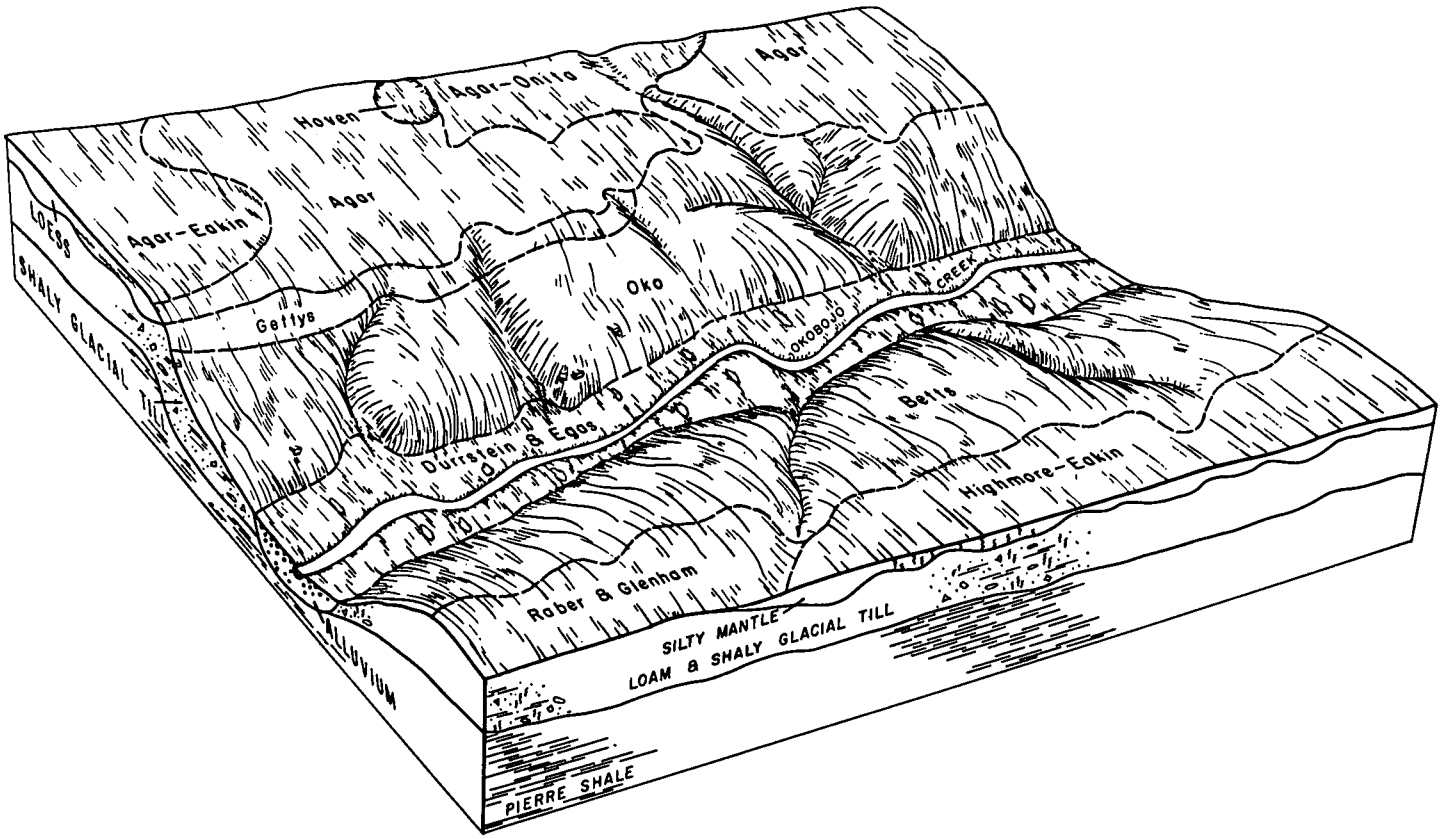


***Figure 4.*—Relative position of major soils bordering Okobojo Creek in central part of county.**

calcareous, grayish-brown and light brownish-gray clay. The underlying material is light brownish-gray and gray clay that contains chips and fragments of shale.

Less extensive in the association are Betts and Gettys soils on the upper part of the slopes; Dupree and Opal soils in some of the hilly areas where the underlying material is clay shale; Durrstein and Egas soils on bottom lands; and DeGrey, Onita, and Promise soils on foot slopes and low terraces. Also included is Clayey alluvial land and Saline and alkali land on bottom lands.

Runoff is rapid on the hilly soils and slow to very slow on the less extensive, poorly drained soils on bottom lands. Control of erosion is the main concern in management.

Most of this association is in native grass used for grazing. Most areas are too steep and stony for use as cropland, but some of the bottom lands are used for hay. Alfalfa is the main crop on the few, scattered, small tracts that are cultivated. Limitations are moderate to severe for many engineering uses.

5. *Highmore-Eakin association*

Deep, nearly level to undulating, well-drained, silty soils formed in silty drift and loamy glacial till; on uplands

This association is a broad, upland plain. It is thinly mantled with silty glacial drift and is underlain by loamy glacial till. The soils in much of the association are nearly level, and there are slight rises and ill-defined drainageways that terminate in small depressions and intermittent lakes. Most slopes are medium to long. The shorter and steeper slopes are mostly along the larger drainageways.

This association makes up about 35 percent of the county. About 30 percent of it is Highmore soils, 20 percent is Eakin soils, and the remaining 50 percent is minor soils.

Highmore soils have a surface layer of dark-gray silt loam. The subsoil is silty clay loam that is dark grayish brown in the upper part and light yellowish brown in the lower part. It is underlain by calcareous, light yellowish-brown silt loam.

Eakin soils are on the rises and higher parts of the landscape. They have a surface layer and a subsoil similar to those of Highmore soils but are underlain by clay loam glacial till at depths between 20 and 40 inches.

Onita soils are the most extensive of the minor soils and make up about 15 percent of the association. They are in broad, slight depressions and in swales. Less extensive are Cavo, DeGrey, Demky, and Walke soils in low areas; Hoven and Macken soils in closed depressions; and Glenham, Java, Peno, and Raber soils that formed in loamy till.

Runoff is slow to medium in much of the association. The major soils are medium in fertility and have moderate permeability and high available water capacity. Conservation of moisture and the control of water erosion and soil blowing are the main concerns in management.

About 65 percent of this association is cropland. Corn, small grain, and alfalfa are the main crops, but the major soils are well suited to all crops commonly grown in the county. Most areas of major soils that are sloping are well suited to terraces, grassed waterways, or similar structures for controlling water. The moderately slow permeability of the underlying glacial till causes moderate to severe limitations to many engineering uses of the soils in this association.

6. *Glenham-Hoven association*

Deep, nearly level to gently undulating, well-drained, loamy soils formed in glacial till and deep, level, claypan soils formed in alluvium in depressions; on uplands

This association is a gently undulating, glacial moraine. It consists of swells and swales that terminate in flat, closed depressions. Slopes are irregular, and they are short to medium in length. The drainage pattern is poorly defined, except in the more sloping areas adjacent to the larger drainageways that lead to North Medicine Knoll Creek.

This association makes up about 5 percent of the county. About 65 percent of it is Glenham soils, 15 percent is Hoven soils, and 20 percent is minor soils (fig. 5).

Glenham soils are on the slightly rounded swells and are well drained. They have a surface layer of dark-gray loam and a subsoil of dark grayish-brown and grayish-brown clay loam. The underlying material is calcareous, light brownish-gray clay loam.

Hoven soils are in the depressions and are poorly drained. They have a surface layer of gray silt loam and a subsoil of dark-gray silty clay. They are underlain by calcareous, grayish-brown clay loam.

Onita soils in swales are the most extensive of the minor soils. Less extensive are Betts and Java soils on the tops and upper sides of ridges and knolls and Cavo and Demky soils in some of the swales.

Runoff is medium in much of the association, but areas of the Hoven soils are ponded. Fertility is medium in Glenham soils, and they have high available water capacity. Permeability is moderate in Glenham soils and moderately slow in the underlying glacial till. Hoven soils have very slow permeability and poor tilth. The main concerns in management are the control of water erosion and soil blowing and the conservation of moisture.

About 25 percent of this association is cultivated. Corn, small grain, and alfalfa are the main crops. Glenham is the main cultivated soil. Hoven soils are mostly in native grass used for hay or grazing. In many areas the soils that have short, irregular slopes are not well suited to terraces or similar structures for controlling water. Limitations to many engineering uses of these soils are moderate to severe.

7. *Oahe-Talmo association*

Nearly level to hilly, well-drained to excessively drained, loamy soils formed in alluvium over sand and gravel; on terraces and uplands

This association consists of several small areas of terraces and uplands that are underlain by outwash sand and gravel. Slopes are mostly nearly level and gently undulating, but steeper areas are along drainageways.

This association makes up about 3 percent of the county. Oahe soils make up 35 percent of it, Talmo soils 20 percent, and minor soils 45 percent.

The well-drained Oahe soils are nearly level to gently undulating and are of moderate depth over sand and

gravel. They have a surface layer of dark-gray loam and a subsoil of dark grayish-brown loam or clay loam. The underlying material is calcareous, light brownish-gray loam to a depth of 25 inches. Below this is calcareous, brown and pale-brown sand and gravel.

The excessively drained Talmo soils are nearly level to hilly. They have a thin surface layer of dark-gray gravelly loam, except in nearly level areas, where the texture is loam instead of gravelly loam. Sand and gravel is at a depth of 8 inches.

Less extensive in the association are Akaska soils in places where silty material is over the gravel, Betts and Java soils in some of the undulating to hilly areas, Durrstein and Egas soils on bottom lands and in low areas, Onita soils in swales, and Ree soils in places where the soil is deep over gravel.

Runoff is slow to medium in much of this association. Oahe soils have low to moderate available water capacity and are somewhat droughty. Talmo soils have low to very low available water capacity and are too droughty for cultivated crops. The main concerns in management are conservation of moisture and the control of water erosion and soil blowing.

Most of this association is in native grass used for grazing. A few areas of Oahe soils and some of the minor soils are in crops. Small grain, corn, and sorghum are the main crops. Nearly level areas of Oahe soils have a potential for irrigation. Limitations to engineering uses range from slight to severe depending on the type of use.

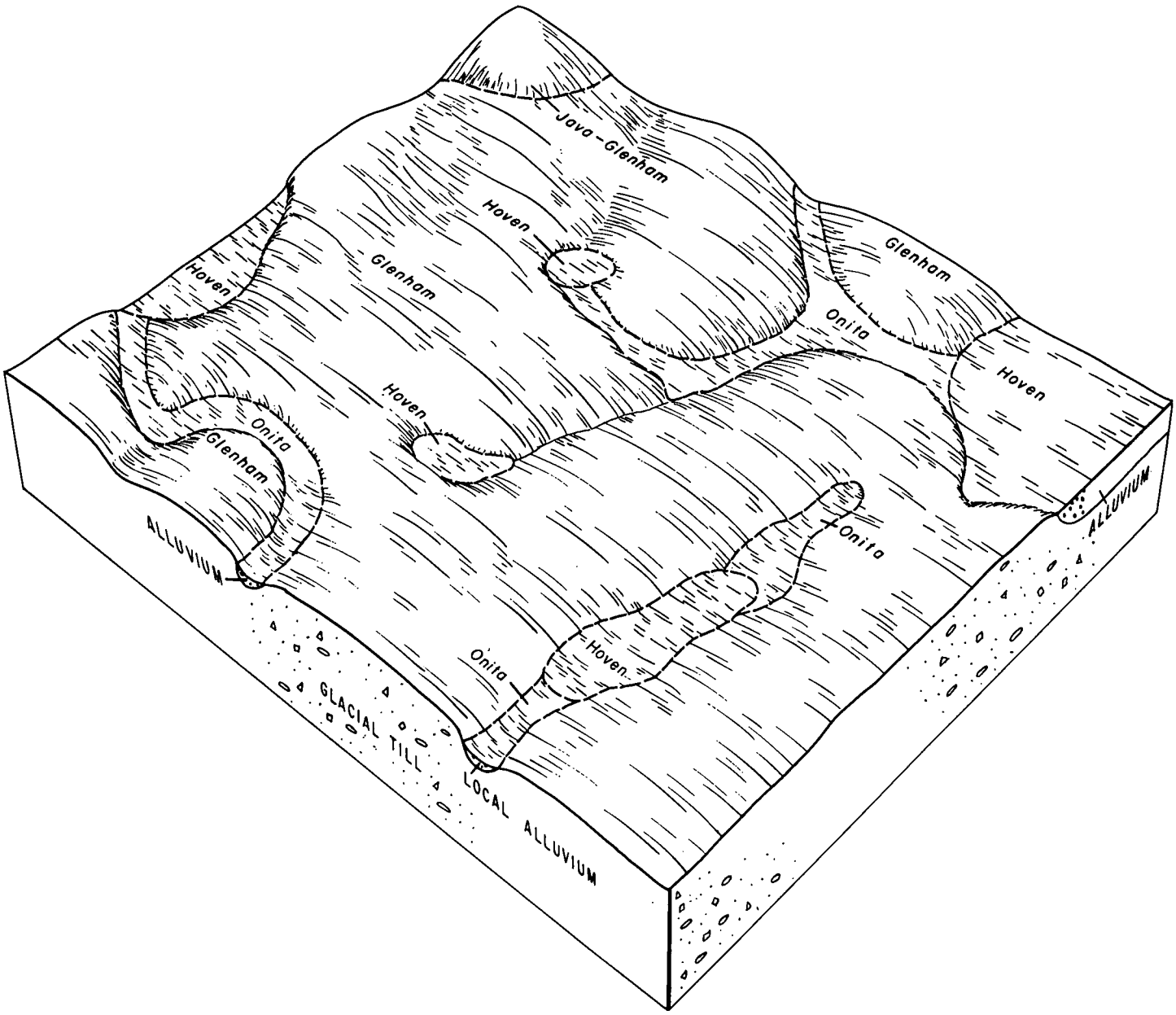


Figure 5.—**Relative position of major soils in the Glenham-Hoven association.**

8. *Highmore-Raber-Cavo association*

Deep, nearly level to gently sloping, well drained and moderately well drained, silty and loamy soils formed in silty drift and glacial till; on uplands

This association is mostly nearly level and is interspersed with slight rises and ill-defined drainageways that flow to North Medicine Knoll Creek.

This association makes up about 2 percent of the county. About 30 percent of it is Highmore soils, 30 percent is Raber soils, 20 percent is Cavo soils, and 20 percent is minor soils.

Highmore soils, on the rises, are nearly level to gently sloping and are well drained. They have a surface layer of dark-gray silt loam and a subsoil of silty clay loam that is underlain by light yellowish-brown silt loam.

Most of the Raber soils are nearly level. They have a surface layer of dark-gray loam and a subsoil of dark grayish-brown and grayish-brown heavy clay loam. The underlying material is calcareous, light brownish-gray heavy clay loam.

The moderately well drained Cavo soils are in slight depressions or low areas and are intermingled with Raber soils. They have a thin surface layer of dark grayish-brown loam and a thin subsurface of grayish-brown loam. Below this is a claypan of heavy clay loam which is underlain by light brownish-gray and light yellowish-brown clay loam.

Less extensive in this association are DeGrey and Walke soils in slight depressions with Highmore soils, Demky soils in areas of Raber and Cavo soils, Eakin soils on the upper part of rises with Highmore soils, Hoven soils in depressions, and Onita soils in swales.

Runoff is slow to medium. Soils in this association are medium in fertility and have moderate to high available water capacity. Permeability ranges from moderate in the Highmore soils to slow or very slow in the Cavo soils. The main concerns in management are conservation of moisture and the improvement of tilth and water intake in the Cavo soils. Cultivated areas of Cavo soils are slow to dry out in spring but become droughty in late summer.

About 65 percent of the association is cropland. Corn, small grain, and alfalfa are the main crops. Many of the areas in native grass are Cavo soils. Limitations to many engineering uses are moderate to severe. This is due to the presence of claypan soils or to the moderately slow permeability of the underlying glacial till.

9. *Raber-Glenham association*

Deep, nearly level to undulating, well-drained, loamy soils formed in glacial till; on uplands

This association consists of a gently undulating to rolling glacial moraine. It is interspersed with swales and drainageways that terminate in closed depressions, sloughs, and lakes. Slopes are mostly gently undulating to undulating, are irregular, and are short to medium in length. Stones are prominent on many of the higher ridges and knolls.

This association makes up about 8 percent of the county. About 40 percent of it is Raber soils, 25 percent is Glenham soils, and 35 percent is minor soils.

Raber soils have a surface layer of dark-gray loam and a subsoil of dark grayish-brown and grayish-brown heavy clay loam. The underlying material is calcareous, light brownish-gray heavy clay loam.

Glenham soils have a profile similar to that of the Raber soils, except that the subsoil and underlying material are less clayey.

Among the minor soils are Betts and Java soils in the more undulating to rolling parts of the association where the ridges and knolls are stony, nearly level to gently sloping Eakin and Highmore soils that are mantled with silty material, Hoven soils in depressions, Onita soils in swales, and Peno soils intermingled with Raber soils.

Runoff is medium in much of the area. The major soils are medium in fertility and have moderate to high available water capacity. Permeability is moderate to slow. The main concerns in management are the control of water erosion and soil blowing and the conservation of moisture.

About 25 percent of this area is cropland. Corn, small grain, and alfalfa are the main crops. Though a potential for more cropland exists, it is limited by the presence of stony ridges and knolls together with poorly drained depressions and sloughs that are interspersed with the arable soils. Terraces or similar structures for controlling water are difficult to install because of the irregularity of slopes. Limitations to many engineering uses of these soils are moderate to severe because the underlying glacial till has moderately slow to slow permeability.

Descriptions of the Soils

This section describes the soil series and mapping units in Sully County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit. Color terms are for dry soil unless otherwise stated.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Clayey alluvial land and Rough broken land, for example, do not belong to a soil series, but nevertheless, are listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit, range

site, and windbreak group in which the mapping unit has been placed. The page for the description of each capability unit, range site, windbreak group, or pasture group can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*6*).[2]

[2] Italic numbers in parentheses refer to Literature Cited, p. 82.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Agar silt loam, 0 to 2 percent slopes	91, 000	14. 2	Oahe-Talmo loams, 0 to 2 percent slopes	3, 151	0. 5
Agar silt loam, 2 to 5 percent slopes	22, 200	3. 2	Oahe-Talmo loams, 2 to 6 percent slopes	2, 516	. 4
Agar silt loam, 5 to 9 percent slopes	5, 844	. 9	Oko clay loam, 0 to 3 percent slopes	771	. 1
Agar-DeGrey silt loams, 0 to 2 percent slopes	4, 025	. 6	Oko clay loam, 3 to 6 percent slopes	1, 150	. 2
Agar-Eakin silt loams, 0 to 2 percent slopes	7, 442	1. 1	Oko clay loam, 6 to 9 percent slopes	1, 000	. 2
Agar-Eakin silt loams, 2 to 5 percent slopes	5, 047	. 8	Oko stony clay loam, 6 to 25 percent slopes	7, 500	1. 2
Agar-Eakin silt loams, 5 to 9 percent slopes	2, 367	. 4	Onita silt loam, 0 to 2 percent slopes	74, 000	11. 5
Agar-Onita silt loams, 0 to 1 percent slopes	13, 900	2. 2	Onita silt loam, 2 to 5 percent slopes	1, 340	. 2
Agar-Walke silt loams, 0 to 2 percent slopes	8, 181	1. 3	Onita-DeGrey silt loams, 0 to 2 percent slopes	2, 400	. 4
Akaska silt loam, 0 to 2 percent slopes	3, 623	. 6	Onita-Hoven silt loams, 0 to 1 percent slopes	14, 300	2. 2
Akaska silt loam, 2 to 5 percent slopes	688	. 1	Opal clay, 2 to 6 percent slopes	275	(1)
Betts loam, 6 to 25 percent slopes	8, 800	1. 4	Opal clay, 6 to 9 percent slopes	470	. 1
Clayey alluvial land	298	(1)	Opal-Dupree clays, 6 to 21 percent slopes	800	. 1
Dupree-Opal clays, 6 to 34 percent slopes	11, 631	1. 8	Promise silty clay, 0 to 2 percent slopes	4, 350	. 7
Dupree-Shale outcrop complex	4, 867	. 8	Promise silty clay, 2 to 5 percent slopes	1, 610	. 3
Durrstein and Egas soils	7, 650	1. 2	Raber-Cavo loams, 0 to 2 percent slopes	9, 020	1. 4
Egas silty clay	1, 750	. 3	Raber-Cavo loams, 2 to 5 percent slopes	1, 320	. 2
Elpam silt loam	490	. 1	Raber-Demky loams, 0 to 2 percent slopes	3, 950	. 6
Gettys clay loam, 6 to 25 percent slopes	4, 700	. 7	Raber-Demky loams, 2 to 5 percent slopes	591	. 1
Glenham loam, 0 to 3 percent slopes	8, 500	1. 3	Raber and Glenham loams, 3 to 6 percent slopes	32, 800	5. 1
Glenham loam, 3 to 6 percent slopes	10, 380	1. 6	Raber and Glenham loams, 6 to 9 percent slopes	3, 200	. 5
Glenham loam, 6 to 9 percent slopes	275	(1)	Raber-Highmore silt loams, 0 to 3 percent slopes	26, 300	4. 1
Highmore silt loam, 0 to 2 percent slopes	6, 380	1. 0	Raber-Highmore silt loams, 5 to 9 percent slopes	497	. 1
Highmore-DeGrey silt loams, 0 to 2 percent slopes	3, 090	. 5	Raber-Peno loams, 3 to 6 percent slopes	10, 300	1. 6
Highmore-Eakin silt loams, 0 to 2 percent slopes	70, 180	10. 9	Raber-Peno loams, 6 to 9 percent slopes	5, 000	. 8
Highmore-Eakin silt loams, 2 to 5 percent slopes	19, 400	3. 0	Ree loam, 0 to 2 percent slopes	4, 490	. 7
Highmore-Walke silt loams, 0 to 2 percent slopes	15, 700	2. 5	Ree loam, 2 to 5 percent slopes	2, 280	. 4
Hoven silt loam	22, 000	3. 5	Ree and Durrstein soils	1, 190	. 2
Hurley silt loam, 0 to 5 percent slopes	3, 957	. 6	Rough broken land	7, 700	1. 2
Java-Betts loams, 6 to 15 percent slopes	4, 800	. 8	Saline and alkali land	580	. 1
Java-Betts stony complex, 3 to 12 percent slopes	9, 100	1. 4	Shale land	1, 400	. 2
Java-Glenham loams, 3 to 9 percent slopes	9, 140	1. 4	Sully silt loam, 12 to 25 percent slopes	1, 010	. 2
Jerauld-Demky loams, 0 to 1 percent slopes	1, 670	. 3	Sully-Lowry silt loams, 3 to 12 percent slopes	372	(1)
Lowry silt loam, 0 to 2 percent slopes	2, 240	. 4	Talmo gravelly loam, 9 to 25 percent slopes	5, 600	. 9
Lowry silt loam, 2 to 5 percent slopes	2, 169	. 3	Gravel pits	158	(1)
Lowry silt loam, 5 to 9 percent slopes	2, 225	. 3	Water (less than 40 acres in size)	7, 100	1. 1
Lowry silt loam, 9 to 12 percent slopes	570	. 1	Total land area	642, 560	100. 0
Macken silty clay loam	940	. 1	Water (more than 40 acres in size)	46, 080	
Oahe loam, 0 to 2 percent slopes	3, 467	. 5	Total area	688, 640	
Oahe loam, 2 to 6 percent slopes	1, 383	. 2			

[1] Less than 0.05 percent.

Agar Series

The Agar series consists of deep, well-drained, nearly level to sloping silty soils on uplands. These soils formed in silty loess (fig. 6).

In a representative profile the surface layer is dark-gray silt loam about 5 inches thick. The subsoil, about 17 inches thick, is silty clay loam. It is dark gray in the upper part, dark grayish brown in the middle, and grayish brown in the lower part. The subsoil is hard when dry and friable when moist. The underlying material is light brownish-gray silty clay loam in the upper part and light brownish-gray silt loam in the lower part. The lower part of the subsoil and all of the underlying material are calcareous.

Agar soils are moderate in content of organic matter and medium in fertility. Permeability is moderate, and runoff is slow to medium. Available water capacity is high.

Most areas are cultivated. Corn, wheat, oats, and alfalfa are the main crops. Native vegetation is mid and short grasses.

Representative profile of Agar silt loam, 0 to 2 percent

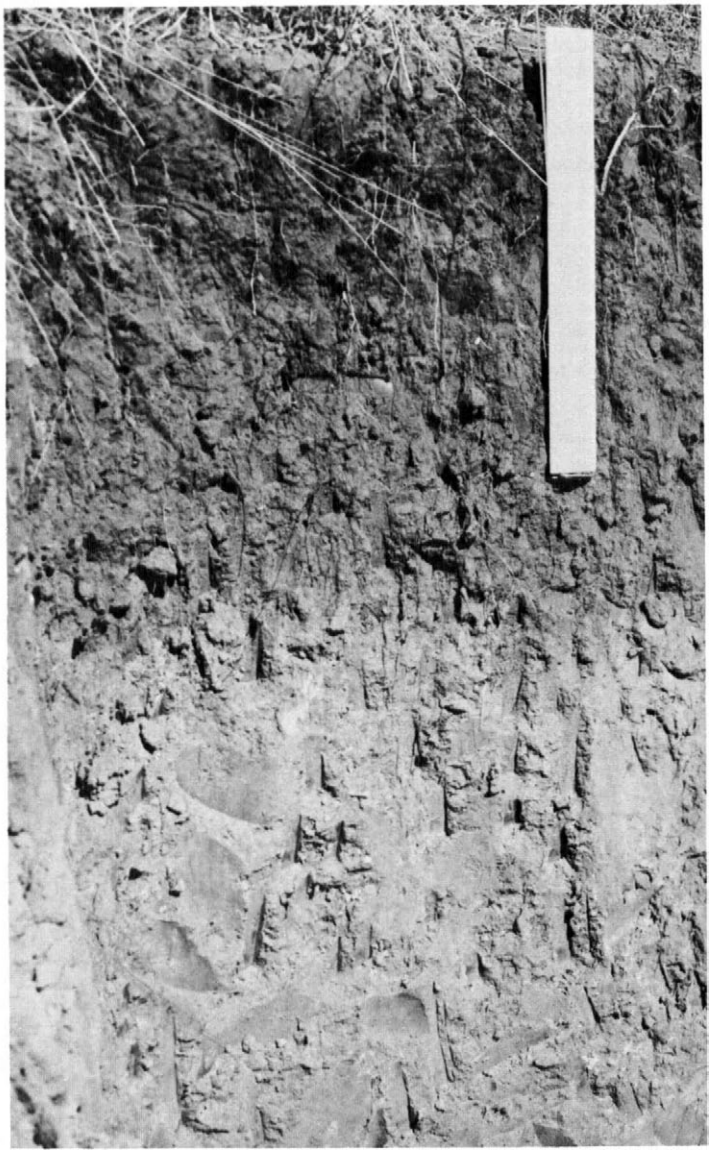


Figure 6.—**Representative profile of Agar silt loam, 0 to 2 percent slopes, formed in deep silty materials.**

slopes, in native grass, 2,290 feet east and 270 feet north of the SW. corner of sec. 32, T. 116 N., R. 79 W.:

A1—0 to 5 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak, very fine, granular structure; slightly hard, friable; slightly acid; clear, wavy boundary.

B21t—5 to 8 inches, dark-gray (10YR 4/1) silty clay loam, dark grayish brown (10YR 4/2) crushed and very dark gray (10YR 3/1) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; neutral; clear, wavy boundary.

B22t—8 to 18 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist and dark grayish brown (10YR 4/2) crushed and moist; moderate, medium, prismatic structure parting to moderate, medium and fine, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; thin continuous clay films on all faces of peds; neutral; clear, wavy boundary.

B3ca—18 to 22 inches, grayish-brown (10YR 5/2) light silty clay loam, dark grayish brown (10YR 4/2) moist; weak, coarse, prismatic structure parting to moderate, medium and fine, subangular blocky structure; hard, friable; few, fine, soft masses of segregated lime; calcareous; mildly alkaline; clear, wavy boundary.

C1ca—22 to 34 inches, light brownish-gray (2.5Y 6/2) light silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; hard, friable; common, medium, soft masses of segregated lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2ca—34 to 40 inches, light brownish-gray (2.5Y 6/2) silt loam; grayish brown (2.5Y 5/2) moist; weak, medium, subangular blocky structure; hard, friable; common, medium, soft masses of segregated lime; calcareous; moderately alkaline; gradual, wavy boundary.

C3—40 to 60 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable; few, fine and medium, soft masses of segregated lime; calcareous; strongly alkaline.

The A horizon ranges from 3 to 8 inches in thickness. It is dark gray or dark grayish brown. Reaction is slightly acid or neutral. The B2t horizon ranges from 8 to 18 inches in thickness. Its prismatic structure ranges from weak to moderate in grade and from medium to fine in size. The C horizon ranges from light brownish gray to light yellowish brown, and hue is 2.5Y or 10YR. The C horizon commonly is silt loam to a depth of more than 60 inches, but in places clay loam glacial till, stratified sand and silt, or clay shale is between depths of 40 and 60 inches.

Agar soils are mapped in complexes with DeGrey, Eakin, Onita, and Walke soils. They lack the A2 horizon that is present in the DeGrey and Walke soils and have less clay in the B horizon than those soils. Agar soils are silty to a greater depth than Eakin soils. They have thinner A and B horizons and have less clay in the B horizon than Onita soils.

Agar silt loam, 0 to 2 percent slopes (AcA).—This soil has long, smooth slopes. It has the profile described as representative for the series. In the more nearly level areas the surface layer is about 7 or 8 inches thick.

Included with this soil in mapping were areas of Eakin soils on some of the slight rises and Onita soils in swales or slight depressions.

Tilth is good, and the soil is free of stones. Runoff is slow, and the hazards of water erosion and soil blowing are slight. Available water capacity is high. The main concerns in management are conservation of moisture and the maintenance of tilth, content of organic matter, and fertility.

Most areas are cultivated. Corn, small grain, and alfalfa are the main crops. This soil is well suited to all crops grown in the county. Capability unit IIc–2; Silty range site; windbreak group 3.

Agar silt loam, 2 to 5 percent slopes (AcB).—This soil has long, smooth slopes. Its profile is similar to the one described as representative for the series, except that in areas of 1 to 3 acres in size, plowing has mixed the original surface layer with the upper part of the subsoil. In these areas the surface layer is now grayish brown or dark grayish brown.

Included with this soil in mapping were areas of Eakin soils on or just below the crests of ridges and Onita soils in swales.

Tilth is good, and the soil is relatively free of stones. Runoff is medium, and the soil is subject to erosion. The

main concern in management is the control of erosion. Also important are conservation of moisture and maintenance of tilth, content of organic matter, and fertility.

More than half the acreage is cultivated. Corn, small grain, and alfalfa are the main crops, but all crops grown in the county are well suited. Capability unit IIe–1; Silty range site; windbreak group 3.

Agar silt loam, 5 to 9 percent slopes (AaC).—This soil has long, smooth slopes. Its profile is similar to the one described as representative for the series, except that the surface layer is about 4 inches thick and the depth to lime is about 14 inches. Where this soil is cultivated it commonly has small eroded areas in which the original surface layer is absent or has been mixed with the subsoil. Included in mapping were areas of Eakin soils on and just below the crests of ridges.

This soil has good tilth and is relatively free of stones. Runoff is medium, and available water capacity is high. The main concern in management is the control of erosion. Also important are conserving moisture and maintaining tilth, content of organic matter, and fertility.

This soil is in crops and in native grass in about equal amounts. Small grain and alfalfa are the main crops. Capability unit IIIe–1; Silty range site; windbreak group 3.

Agar-DeGrey silt loams, 0 to 2 percent slopes (AdA).—Agar soils make up about 50 percent of this complex; DeGrey soils, 35 percent; and other soils, 15 percent. Agar soils are on very slight rises. They have a profile similar to that described as representative for their series, but the underlying material at a depth of 50 inches is clay loam. DeGrey soils are in slight depressions that are circular in shape and commonly small in size. The soil that has the profile described as representative for the DeGrey series is in this complex.

Included with these soils in mapping were areas of Eakin, Hoven, and Walke soils. Eakin soils are intermingled with Agar soils. Hoven soils are in small, closed depressions. Walke soils are on the outer edges of areas of DeGrey soils in slight depressions.

Runoff is slow. Agar soils have good tilth, but the DeGrey soils have poor tilth and are hard to work. Permeability is slow to very slow in the DeGrey parts of the areas. The claypan subsoil in DeGrey soils releases moisture slowly to plants so that crops grow unevenly in areas of this complex. The main concerns in management are conserving moisture and improving tilth and water intake. Also, management is needed to maintain content of organic matter and fertility and to control soil blowing.

About half of this complex is in cultivated crops, and half is in native grass. Corn, small grain, and alfalfa are the main crops. Corn is less well suited in the DeGrey parts of the complex. Capability unit IVs–2; Agar soils in Silty range site and windbreak group 3; DeGrey soils in Claypan range site and windbreak group 9.

Agar-Eakin silt loams, 0 to 2 percent slopes (AeA).—Agar soils make up 60 to 75 percent of this complex and Eakin soils, 25 to 40 percent. Agar soils have longer and smoother slopes than Eakin soils. Eakin soils are on convex slight rises. The soil that the profile described as representative for the Eakin series is in this complex.

Included with these soils in mapping were small areas of Onita soils in swales and Raber soils on some of the slight rises.

Tilth is good. Runoff is slow, permeability is moderate, and available water capacity is high. The main concern in management is conservation of moisture. Other management needs are the control of soil blowing and the maintenance of tilth, content of organic matter, and fertility.

Most areas are cultivated. Corn, small grain, and alfalfa are the main crops. Capability unit IIc–2; Silty range site; windbreak group 3.

Agar-Eakin silt loams, 2 to 5 percent slopes (AeB).—Agar soils make up 55 to 70 percent of this complex and Eakin soils, 30 to 45 percent. Agar soils are on the mid and lower parts of the landscape, and Eakin soils are on the higher parts and ridgetops. Both soils have a profile similar to that described for their respective series, except that eroded areas are along the crests of slopes where the surface layer and subsoil have been mixed by plowing. Included in mapping were small areas of Raber soils that are intermingled with Eakin soils.

Runoff is medium, and these soils are susceptible to erosion. Permeability is moderate, and available water capacity is high. The main concern in management is the control of water erosion and soil blowing. Also, management is needed to conserve moisture and to maintain tilth, content of organic matter, and fertility.

About half of this complex is in cultivated crops, and half is in native grass. Corn, small grain, and alfalfa are the main crops. Capability unit IIe–1; Silty range site; windbreak group 3.

Agar-Eakin silt loams, 5 to 9 percent slopes (AeC).—Agar soils make up about 55 percent of this complex; Eakin soils, 40 percent; and minor soils, 5 percent. Areas are irregular in shape and about 25 acres in size. Agar soils are on the longer, mid and lower side slopes, and they have a thinner surface layer than that of the profile described as representative for their series. Eakin soils are on the higher rises and commonly have shorter slopes than Agar soils. Their profile is similar to the one described as representative for the Eakin series, but the surface layer is thinner. Small eroded spots are in cultivated areas. These spots have a lighter colored surface layer because plowing has mixed the surface layer and subsoil.

Raber soils are the most common among the minor soils in this complex. They are on or just below ridge crests, and they commonly have a few cobblestones on the surface.

Runoff is medium, and the soils are susceptible to erosion. Permeability is moderate, and available water capacity is high. Control of erosion is the main concern in management. Other management needs are conservation of moisture and maintenance of tilth, content of organic matter, and fertility.

These soils are in crops and in native grass in about an equal acreage. Corn, small grain, and alfalfa are the main crops. Capability unit IIIe–1; Silty range site; windbreak group 3.

Agar-Onita silt loams, 0 to 1 percent slopes (AgA).—Agar soils make up 50 to 65 percent of this complex and Onita soils, 35 to 50 percent. Agar soils are on very slight

rises and have a thicker surface layer than that of the profile described as representative for their series. Onita soils are in very slight depressions and swales. The difference in elevation between the two soils generally is less than 3 feet. The surface layer of the Onita soil is thinner than that of the profile described as representative for their series. Some areas of this complex are as large as 1,000 acres.

Runoff is slow, and the hazard of erosion is slight. Available water capacity is high. Conservation of moisture is the main concern in management. Also, management is needed to control soil blowing and to maintain tilth, content of organic matter, and fertility.

Most areas of this complex are cultivated. Corn, small grain, and alfalfa are the main crops, but all crops common to the county grow well because of good moisture relationship and medium to high fertility. Capability unit IIc–2; Agar soils in Silty range site and windbreak group 3; Onita soils in Overflow range site and windbreak group 1.

Agar-Walke silt loams, 0 to 2 percent slopes (AkA).—Agar soils make up 40 to 55 percent of this complex; Walke soils, 20 to 40 percent; and other soils, 20 to 25 percent. Agar soils are on slight rises. They have a thicker surface layer than that of the profile described as representative for their series. Walke soils are in slight depressions between the rises.

Included with this soil in mapping were areas of DeGrey, Eakin, and Onita soils. DeGrey and Onita soils are in swales and along ill-defined drainageways. Eakin soils are on slight rises with the Agar soils.

Runoff is slow, and the erosion hazard is slight. Permeability is moderate in the Agar soils but slow in the Walke soils. Agar soils have good tilth. Walke soils have a subsoil that is hard when dry and sticky when wet. The main concern in management is the improvement of tilth and water intake in the Walke soils and the conservation of moisture. Also, management is needed to control soil blowing and to maintain content of organic matter and fertility.

Most areas are cultivated. Corn, small grain, and alfalfa are the main crops.

Capability unit IIc–2; Agar soils in Silty range site and windbreak group 3; Walke soils in Clayey range site and windbreak group 4.

Akaska Series

The Akaska series consists of well-drained, nearly level to gently sloping, silty soils that are moderately deep over sand and gravel. These soils formed in silty deposits on terraces and uplands.

In a representative profile, the surface layer is very dark grayish-brown silt loam about 6 inches thick. The subsoil, about 21 inches thick, is silty clay loam that is dark grayish brown in the upper part, grayish brown in the middle, and light brownish gray and calcareous in the lower part. The subsoil is hard when dry and friable when moist. The underlying material is calcareous, light brownish-gray silty clay loam. Brown sand and gravel is at a depth of 37 inches.

Akaska soils are moderate in content of organic matter and medium in fertility. Available water capacity is moderate. Permeability is moderate in the surface layer and subsoil, but it is rapid in the underlying sand and gravel. Runoff is slow to medium.

Most areas are cultivated. Corn, small grain, and alfalfa are the main crops. The native vegetation consists of mid and short grasses.

Representative profile of Akaska silt loam, 0 to 2 percent slopes, in native grass, 2,470 feet east and 720 feet north of the SW. corner of sec. 27, T. 114 N., R. 79 W.:

A1—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; moderate, fine, granular structure; soft, friable; neutral; clear, smooth boundary.

B21t—6 to 14 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; thin patchy clay films; neutral; clear, smooth boundary.

B22t—14 to 17 inches, grayish-brown (10YR 5/2) silty clay loam; dark grayish brown (10YR 4/2) moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; thin patchy clay films; calcareous; mildly alkaline; clear, smooth boundary.

B3ca—17 to 27 inches, light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; weak, coarse, prismatic structure parting to weak, medium and fine, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common, medium and fine, soft masses of segregated lime; calcareous; moderately alkaline; clear, smooth boundary.

C1ca—27 to 37 inches, light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; common, fine, soft masses of segregated lime; calcareous; moderately alkaline; clear, smooth boundary.

IIC2—37 to 60 inches, brown (10YR 5/3) sand and gravel, dark brown (10YR 4/3) moist; single grained; loose; neutral.

Depth to sand and gravel ranges from 20 to 40 inches and depth to lime from 14 to 26 inches. The A horizon ranges from 4 to 8 inches in thickness and from dark gray to very dark grayish brown in color. The B2t horizon ranges from 10 to 18 inches in thickness, and it is silty clay loam or heavy silt loam. The C1ca horizon commonly is silty clay loam or silt loam, but it is gravelly loam in places.

Akaska soils are near Agar, Highmore, Oahe, and Ree soils. They differ from Agar, Highmore, and Ree soils in having sand and gravel at a depth of less than 40 inches. They are more silty than Oahe soils.

Akaska silt loam, 0 to 2 percent slopes (AlA).—This soil is mainly on high terraces along Okobojo Creek. It has the profile described as representative for the series. Sand and gravel commonly are at a depth of 28 to 40 inches.

Included with this soil in mapping were areas of Agar soils where the silty material is more than 40 inches deep over gravel and areas of Onita soils in swales. These inclusions make up less than 10 percent of any mapped area.

Tilth is good, and the soil is relatively free of stones. Available moisture capacity is moderate, but the soil is somewhat droughty for deep-rooted crops. Conservation of moisture is the main concern in management. Also, management is needed to control soil blowing and to maintain tilth, content of organic matter, and fertility.

Many areas are cultivated. Corn, small grain, and alfalfa are the main crops. Early-maturing small grain and such drought-resistant crops as sorghum are better suited to this soil than corn and alfalfa. Capability unit IIIs–2; Silty range site; windbreak group 6.

Akaska silt loam, 2 to 5 percent slopes (AlB).—This soil is mainly on terraces along Okobojo and North Medicine Knoll Creeks. Sand and gravel commonly are at a depth of 24 to 40 inches. Included in mapping were areas of Agar soils where the silty material is more than 40 inches deep over the underlying sand and gravel.

Tilth is good, and the soil is relatively free of stones. Available water capacity is moderate, but the soil is somewhat droughty for deep-rooted crops. Runoff is medium, and the soil is susceptible to water erosion and soil blowing. Management concerns are conservation of moisture and the maintenance of tilth, content of organic matter, and fertility.

This soil is in crops and in native grass in about an equal acreage. Small grain, corn, sorghum, and alfalfa are the main crops. Early maturing small grain and sorghum are better suited than corn and alfalfa. Capability unit IIIe–6; Silty range site; windbreak group 6.

Betts Series

The Betts series consists of deep, excessively drained, undulating to hilly, loamy soils on uplands. These soils formed in friable, calcareous glacial till.

In a representative profile the surface layer is dark-gray loam about 2 inches thick. The subsoil is grayish-brown, calcareous, light clay loam about 3 inches thick. It is slightly hard when dry and friable when moist. The underlying material is calcareous clay loam. The upper part of this material is light brownish gray and contains soft masses of segregated lime. The lower part is light yellowish brown and contains gypsum crystals.

Betts soils are low in content of organic matter and fertility but have high available water capacity. Permeability is moderate in the surface layer and subsoil and moderately slow in the underlying material. Runoff is rapid.

Most areas are in native grass used for grazing. A few small areas of Betts soils are farmed along with other soils that are better suited to cultivation.

Representative profile of Betts loam, 6 to 25 percent slopes, 454 feet north and 328 feet east of the SW. corner of sec. 21, T. 115 N., R. 77 W.:

A1—0 to 2 inches, dark-gray (10YR 4/1) loam, very dark grayish brown (10YR 3/2) moist and dark grayish brown (10YR 4/2) crushed and moist; weak, fine, granular structure; soft, friable; neutral; clear, smooth boundary.

B2—2 to 5 inches, grayish-brown (2.5Y 5/2) light clay loam, very dark grayish brown (2.5Y 3/2) moist and dark grayish brown (10YR 4/2) crushed and moist; weak, medium, prismatic structure parting to weak, medium and coarse, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—5 to 21 inches, light brownish-gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/3) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; few strong-brown (7.5YR 5/8) iron stains; common, fine, soft masses of segregated lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2cs—21 to 60 inches, light yellowish-brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; few to common gypsum crystals; calcareous; moderately alkaline.

Rounded gravel, cobblestones, and stones are on the surface in places. The A horizon is commonly loam but in places it is silt loam or gravelly loam. It ranges from 2 to 4 inches in thickness. In cultivated areas this horizon is calcareous. The B horizon ranges from 2 to 6 inches in thickness and from dark grayish brown to light brownish gray in hue of 10YR or 2.5Y. Texture is loam or light clay loam. The C horizon is loam or clay loam and has few to many mottles and stains.

Betts soils are mapped with or are near Gettys, Glenham, Java, and Talmo soils. They contain less clay than Gettys soils and have thinner A and B horizons than Glenham and Java soils. Betts soils contain more clay and less sand and gravel than Talmo soils.

Betts loam, 6 to 25 percent slopes (BeE).—This undulating to hilly soil is on the sides of valleys that border the larger creeks in the county. Slopes are short and convex. Cobblestones and stones that range from 6 to 36 inches in diameter are on the surface in some areas.

Included with this soil in mapping were areas of Glenham, Java, Onita, and Ree soils. Glenham soils are the most common of these and are in the mid and lower parts of the landscape. Java soils are between the Betts and Glenham soils. Onita and Ree soils are in swales and on foot slopes. Inclusions make up less than 20 percent of any mapped area.

This soil is low in content of organic matter and in fertility. Runoff is rapid, and the soil is susceptible to erosion. The main concern in management is the control of erosion.

Nearly all areas are in native grass. Stoniness in some areas, together with steepness of slope, limits the use of this soil to grazing. Capability unit VIe–3; Thin Upland range site; windbreak group 10.

Cavo Series

The Cavo series consists of deep, moderately well drained, nearly level to gently sloping, loamy soils that have a compact, slowly permeable subsoil. These soils formed in clay loam glacial till on uplands.

In a representative profile the surface layer is dark grayish-brown loam about 4 inches thick. The subsurface layer is grayish-brown loam about 2 inches thick. The subsoil is about 20 inches of clay loam. It is dark grayish brown in the upper part, grayish brown in the middle, and light brownish gray in the lower part. In addition, the upper part of the subsoil is very hard when dry and firm when moist, and the lower part is calcareous. The underlying material is calcareous clay loam that is light brownish gray in the upper part and light yellowish brown in the lower part.

Cavo soils are moderate in content of organic matter and medium in fertility. Permeability is slow to very slow, and runoff is slow to medium. Available water capacity is moderate to high.

Many areas of these soils are in native grass used for grazing. Corn, small grain, and alfalfa are the main crops in cultivated areas.

In Sully County Cavo soils are mapped only with Raber soils.

Representative profile of Cavo loam in an area of Raber-Cavo loams, 0 to 2 percent slopes, in native grass, 1,245 feet south and 210 feet east of the NW. corner of sec. 31, T. 113 N., R. 74 W.:

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) loam, very dark gray (10YR 3/1) moist and very dark grayish brown (10YR 3/2) crushed and moist; weak, fine, platy structure parting to weak, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

A2—4 to 6 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; prominent, gray (10YR 6/1), clear silt and sand grains; weak, thick, platy structure parting to weak, fine, granular structure; soft, friable; neutral; abrupt, smooth boundary.

B21t—6 to 10 inches, dark grayish-brown (10YR 4/2) heavy clay loam, very dark grayish brown (10YR 3/2) moist; thin, continuous, light-gray (10YR 7/1) coatings on tops of columns; moderate, medium, columnar structure parting to strong, medium and fine, blocky structure; very hard, firm, sticky, plastic; thin continuous clay films on faces of peds; mildly alkaline; clear, smooth boundary.

B22t—10 to 13 inches, grayish-brown (2.5Y 5/2) heavy clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, blocky structure; very hard, firm, sticky, plastic; thin continuous clay films on faces of peds; moderately alkaline; gradual, wavy boundary.

B3ca—13 to 26 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; hard, firm, sticky, plastic; few, fine, gypsum crystals; common, medium, soft masses of segregated lime; calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—26 to 39 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, sticky, slightly plastic; few, fine, gypsum crystals; few, fine, soft masses of segregated lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2—39 to 60 inches, light yellowish-brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable, sticky, slightly plastic; few, fine, reddish-yellow (7.5YR 6/8) iron stains; few, fine, gypsum crystals; calcareous; moderately alkaline.

The A horizon is loam or silt loam. The A1 horizon ranges from 3 to 5 inches in thickness and from dark gray to grayish brown in color. The A2 horizon ranges from 1 to 3 inches in thickness and from grayish brown to light gray in color. The B2t horizon is clay loam or clay. Its columnar structure is moderate or strong. In the B3ca and C1ca horizons soft masses and striations of segregated lime range from few to many. In the C horizon nests of gypsum crystals range from few to many.

Cavo soils resemble DeGrey soils and are near or are mapped with Demky, Jerauld, and Raber soils. They contain more sand and are less silty than DeGrey soils. Cavo soils lack the B&A horizon that is typical of the Demky soils, which do not have columnar structure. They have thicker A and B horizons than Jerauld soils. Cavo soils have an A2 horizon and columnar structure, which are lacking in Raber soils. Also, they have more sodium in the B2t horizon than Raber soils.

Clayey Alluvial Land

Clayey alluvial land (0 to 2 percent slopes) (Cd) consists of mixed soils that formed in alluvium on bottom lands along creeks and drainageways that flow into Lake Oahe. Areas are long and narrow. They are dissected into small parcels by meandering channels. The surface layer commonly is silty clay or silty clay loam, but it is sandy clay or clay in places. Below the surface layer are stratified materials that are mostly clay and silt. Included in the areas mapped are small areas of Ree soils at slightly higher elevations.

This land is somewhat poorly drained. It is flooded almost every year, and fresh sediment and debris are deposited. The hazard of flooding, the small size, and the irregular shape of the areas make cultivation impractical.

All areas are in native vegetation used for grazing. Scattered native trees grow in clumps or singly and provide shelter for wildlife and livestock. Capability unit VIw–1; Overflow range site; windbreak group 10.

DeGrey Series

The DeGrey series consists of deep, moderately well drained, nearly level, silty soils that have a claypan subsoil. These soils formed in silty materials over glacial till on uplands.

In a representative profile the surface layer is dark-gray silt loam about 4 inches thick. The subsurface layer is gray silt loam about 2 inches thick. The subsoil, about 13 inches thick, is dark grayish-brown silty clay in the upper part and grayish-brown calcareous silty clay in the lower part. In addition it is very hard when dry and very firm when moist. The underlying material is calcareous, light brownish-gray silty clay loam in the upper part and calcareous, light brownish-gray clay loam in the lower part.

DeGrey soils are moderate in content of organic matter and medium in fertility. Permeability is slow to very slow, and runoff is slow. The available water capacity is moderate to high.

About half the acreage is cultivated. Corn, small grain, and alfalfa are the main crops. The native vegetation consists of mid and short grasses.

In Sully County DeGrey soils are mapped only with Agar, Highmore, and Onita soils.

Representative profile of DeGrey silt loam in native grass in an area of Agar-DeGrey silt loams, 0 to 2 percent slopes, 1,118 feet north and 182 feet west of the center of sec. 3, T. 113 N., R. 79 W.:

A1—0 to 4 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak, medium and fine, granular structure; soft, friable; neutral; clear, smooth boundary.

A2—4 to 6 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak, fine, platy structure; soft, very friable; neutral; abrupt, smooth boundary.

B21t—6 to 9 inches, dark grayish-brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) crushed and very dark grayish brown (10YR 3/2) moist; moderate, medium, columnar structure parting to strong, medium and fine, blocky structure; very hard, very firm, sticky, plastic; thin continuous clay films on faces of peds; moderately alkaline; clear, smooth boundary.

B22t—9 to 14 inches, dark grayish-brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) crushed, and very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to strong, medium and fine, blocky structure; very hard, very firm, sticky, plastic; thin continuous clay films on all faces of peds; moderately alkaline; clear, smooth boundary.

B3ca—14 to 19 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure parting to moderate, coarse, subangular blocky structure; very hard, very firm, sticky, plastic; thin patchy clay films on vertical faces of peds; few fine masses and threads of segregated lime; calcareous; moderately alkaline; clear, wavy boundary.

C1ca—19 to 36 inches, light brownish-gray (2.5Y 6/2) silty clay loam, light olive brown (2.5Y 5/4) moist; weak, fine, subangular blocky structure; hard, firm, slightly sticky, slightly plastic; few fine segregations of lime; calcareous; moderately alkaline; clear, wavy boundary.

IIC2ca—36 to 47 inches, light brownish-gray (2.5Y 6/2) heavy clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, firm, sticky, plastic; few, fine, yellowish-red (5YR 5/8) iron stains; few fine pebbles as much as ½ inch in diameter; common medium segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

IIC3—47 to 60 inches, light brownish-gray (2.5Y 6/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; massive; very hard, firm, sticky, plastic; few, fine and medium, yellowish-red (5YR 5/8) iron stains; few to common, fine, weathered shale fragments; few fine gypsum crystals; calcareous; moderately alkaline.

The A1 horizon ranges from 3 to 7 inches in thickness and from dark gray to grayish brown in color. The A2 horizon ranges from 1 to 4 inches in thickness and from gray to light gray in color. The B2t horizon ranges from 6 to 13 inches in thickness and is silty clay or clay. In the B3ca and C1ca horizons, lime segregations range from few to many. Depth to glacial till ranges from 20 to 40 inches, and in places the B3ca horizon formed in that material.

DeGrey soils have a profile similar to that of Cavo soils. They are mapped with or are near Agar, Highmore, Hoven, Onita, and Walke soils. DeGrey soils contain less sand and are more silty than Cavo soils. Their Bt horizon is more clayey than that of Agar or Highmore soils. They are better drained than Hoven soils. They differ from Onita soils in having an A2 horizon and columnar structure in the upper part of the B2t horizon. In contrast to this columnar structure in the upper part of the B2t horizon of DeGrey soils, Walke soils have prismatic structure.

Demky Series

The Demky series consists of deep, moderately well drained, level to gently sloping, loamy soils that have a claypan subsoil. These soils formed in glacial till on uplands.

In a representative profile the surface layer is about 6 inches of loam. It is dark gray in the upper part and grayish brown in the lower part. Below this is a transitional layer of about 2 inches of grayish-brown clay loam. The subsoil, about 14 inches thick, is grayish-brown heavy clay loam in the upper part and calcareous, light brownish-gray clay loam in the lower part. Also, the upper part is very hard when dry and firm when moist. The underlying material is calcareous, light brownish-gray clay loam.

Demky soils are moderate in content of organic matter and medium in fertility. Permeability is slow, and runoff is slow to medium. The available water capacity is moderate to high.

Many areas are in native grass which is grazed or used for hay. In cultivated areas corn, small grain, and alfalfa are the main crops.

In Sully County Demky soils are mapped only with Jerauld and Raber soils.

Representative profile of Demky loam in native grass in an area of Raber-Demky loams, 0 to 2 percent slopes, 1,834 feet north and 488 feet west of the SE. corner of sec. 27, T. 114 N., R. 76 W.:

A11—0 to 3 inches, dark-gray (10YR 4/1) loam, dark grayish brown (10YR 4/2) crushed and very dark gray (10YR 3/1) moist; weak, fine, platy structure; soft, friable; neutral; clear, smooth boundary.

A12—3 to 6 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure; soft, friable; neutral; clear, smooth boundary.

B&A—6 to 8 inches, grayish-brown (10YR 5/2) clay loam (B part), very dark grayish brown (10YR 3/2) moist, and thin, nearly continuous, gray (10YR 6/1) coatings of silt and very fine sand (A part) on faces of peds; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; neutral; clear, smooth boundary.

B2t—8 to 14 inches, grayish-brown (2.5Y 5/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; thin, patchy, dark grayish-brown (10YR 4/2) coatings on vertical faces of peds, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to strong, medium, blocky structure; very hard, firm, sticky, plastic; thin continuous clay films on faces of peds; mildly alkaline; gradual, wavy boundary.

B3ca—14 to 22 inches, light brownish-gray (2.5Y 6/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; hard, firm, sticky, plastic; common medium and coarse segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—22 to 36 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky, plastic; common fine segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2—36 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; common, fine, light-gray (2.5Y 7/1) mottles; massive; hard, firm, sticky, plastic; few, fine, yellowish-red (5YR 5/8) iron concretions; few fine nests of gypsum crystals; calcareous; moderately alkaline.

Depth to lime ranges from 12 to 18 inches. The A1 horizon ranges from 5 to 9 inches in thickness and from dark gray to grayish brown in color. Texture is loam or silt loam. The B&A horizon commonly is clay loam, but in places it is loam or silty clay loam. It ranges from 2 to 4 inches in thickness. The B2t horizon is clay loam or clay. In the B3ca and C1ca horizons, segregations of lime are few to common. In the C2 horizon nests of gypsum crystals are few to common.

Demky soils resemble Cavo and Walke soils and are mapped with Jerauld and Raber soils. They lack the distinct A2 horizon and columnar structure in the B2t horizon that are characteristic of Cavo and Jerauld soils. They are less silty than Walke soils. Demky soils contain more sodium in the B horizon than Raber soils and are not so well drained.

Dupree Series

The Dupree series consists of shallow, well-drained, sloping to steep, clayey soils on uplands. These soils formed in clayey materials that weathered from the underlying clay shales.

In a representative profile the surface layer is gray clay about 2 inches thick. The subsoil, about 7 inches thick, is olive-gray clay. It is very hard when dry, very

firm when moist, and sticky and plastic when wet. The underlying material is light olive-gray clay to a depth of 16 inches. Below this is light olive-gray and gray shale.

Dupree soils are moderately low in content of organic matter and low in fertility. Permeability is slow to very slow, and runoff is medium to rapid. Available water capacity is very low.

All areas are in native grass used for grazing.

Representative profile of Dupree clay in native grass in an area of Dupree-Opal clays, 6 to 34 percent slopes, 2,400 feet north and 351 feet west of the SE. corner of sec. 1, T. 114 N., R. 81 W.:

A1—0 to 2 inches, gray (5Y 5/1) clay, very dark grayish brown (2.5Y 3/2) moist; moderate, fine, granular structure; hard, firm, sticky, plastic; neutral; clear, wavy boundary.

B2—2 to 9 inches, olive-gray (5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, medium, subangular blocky structure and weak, fine, blocky structure; very hard, very firm, sticky, plastic; mildly alkaline; gradual, wavy boundary.

C1—9 to 16 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 5/2) moist; massive; hard, firm, sticky, plastic; mildly alkaline; gradual, wavy boundary.

C2—16 to 60 inches, light olive-gray (5Y 6/2) and gray (5Y 5/1) soft shale, olive gray (5Y 5/2) and dark gray 5Y 4/1) moist; bedded; few to common yellow (2.5Y 7/6) and brownish-yellow (10YR 6/8) stains and mottles in seams between plates; few to common nests of gypsum crystals; mildly alkaline.

Depth to bedded shale ranges from 6 to 20 inches. The soil commonly is noncalcareous but in places it is calcareous. Cracks form when the soil is dry. Some are as much as 2 inches wide and several feet long, and they extend downward to the bedded shale. The A horizon ranges from dark gray to olive gray in hue of 10YR, 2.5Y, or 5Y, and from 1 to 4 inches in thickness. This horizon is clay or silty clay. In places fragments of shale are in the B2 and C1 horizons.

Dupree soils are mapped with or are near Gettys, Hurley, Oko, and Opal soils. They have shale at a shallower depth than those soils. Dupree soils are more clayey than Gettys and Oko soils and contain less sodium than Hurley soils.

Dupree-Opal clays, 6 to 34 percent slopes (DoF).—Dupree soils make up 60 percent of this complex; Opal soils, 25 percent; and other soils, 15 percent. Areas are large and are cut by many eroded drainageways that cannot be crossed by a vehicle. Rounded stones and boulders are on the surface in places, and these are remnants of glacial deposits, most of which have eroded away. The steep Dupree soils are on the upper parts of side slopes and on ridgetops. The soil that has the profile described as representative for the Dupree series is in the complex. Opal soils are on the mid and lower parts of side slopes. Their surface layer is thinner than that of the profile described as representative for the series, and shale commonly is at a depth of 24 inches.

Included with these soils in mapping were areas of Oko soils, mostly in and around stony areas, and areas of Promise soils on foot slopes and in swales.

Permeability is slow or very slow, and runoff is rapid. Available water capacity is low or very low. Control of erosion and conservation of moisture are concerns in management.

All areas are in native grass used for grazing. Capability unit VIIs–2 and windbreak group 10; Dupree soils in Dense Clay range site; Opal soils in Clayey range site.

Dupree-Shale outcrop complex (6 to 40 percent slopes) (Ds).—Dupree soils make up 60 to 85 percent of this complex and Shale outcrop, 15 to 40 percent. Areas average about 200 acres in size and in places contain deep, actively eroding gullies. Shale outcrop consists of exposed beds of soft shale on the shoulders and around the heads of eroding drainageways and on nearly vertical banks and side slopes.

Runoff is rapid, and these soils are highly erodible. The available water capacity is very low. These soils are too shallow for cultivation. Control of erosion and conservation of moisture are concerns in management.

All areas are in native vegetation used for grazing. The Shale outcrop part is either barren or nearly devoid of vegetation. Dupree soils in capability unit VIIs–2, Dense Clay range site, and windbreak group 10; Shale outcrop in capability unit VIIIs–2, not placed in a range site or a windbreak group.

Durrstein Series

The Durrstein series consists of deep, poorly drained, level, silty soils that have a claypan subsoil. These soils formed in clayey alluvium and are on bottom lands.

In a representative profile the surface layer is gray silt loam about 3 inches thick. The subsoil, about 13 inches thick, is dark-gray clay in the upper part and grayish-brown silty clay in the lower part. The subsoil is very hard when dry and very firm when moist. In addition the lower part is calcareous and contains spots and streaks of salts. The underlying material, which reaches a depth of 42 inches, is calcareous, gray silty clay that has spots and streaks of salts. Below that depth is calcareous, olive-gray silty clay.

Durrstein soils are moderate in content of organic matter and medium in fertility. Permeability is slow to very slow, and runoff is slow. The available water capacity is low to moderate. A water table fluctuates between depths of 3 and 8 feet.

Most areas are in native grass used for grazing. Alfalfa is the main crop in the few areas that are cultivated.

Representative profile of Durrstein silt loam in an area of Durrstein and Egas soils, 1,696 feet south and 279 feet west of the NE. corner of sec. 8, T. 116 N., R. 75 W.:

A2—0 to 3 inches, gray (10YR 6/1) silt loam, dark gray (10YR 4/1) moist; weak, medium, platy structure parting to weak, fine, granular structure; soft, friable; neutral; abrupt, smooth boundary.

B21t—3 to 8 inches, dark-gray (10YR 4/1) clay, black (10YR 2/1) moist and very dark grayish brown (10YR 3/2) crushed and moist; moderate, medium, columnar structure parting to strong, fine, subangular blocky and blocky structure; very hard, very firm, sticky, plastic; moderately alkaline; clear, smooth boundary.

B22t—8 to 11 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; very hard, very firm, sticky, plastic; moderately alkaline; clear, smooth boundary.

B3sa—11 to 16 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate, coarse, blocky structure; very hard, firm, sticky, plastic; few fine striations and nests of salts; calcareous; moderately alkaline; clear, smooth boundary.

Ccasa—16 to 42 inches, gray (5Y 5/1 and 5Y 6/1) silty clay, dark gray (5Y 4/1) and gray (5Y 5/1) moist; weak,

medium and coarse, subangular blocky structure; very hard, firm, sticky, plastic; common fine striations and nests of salts; few fine segregations of lime; calcareous; moderately alkaline; abrupt, smooth boundary.

Ab—42 to 60 inches, olive-gray (5Y 5/2) silty clay, dark olive gray (5Y 3/2) moist; weak, medium, subangular blocky structure; hard, firm, sticky, plastic; calcareous; moderately alkaline.

Depth to lime and to nests of salts ranges from 7 to 15 inches. The A2 horizon ranges from gray to light brownish gray and is 1 to 4 inches thick. Texture is silt loam, silty clay loam, or loam. The B21t horizon ranges from 4 to 6 inches in thickness. Texture is clay or silty clay. The columnar structure in this horizon ranges from weak to moderate in grade and from medium to fine in size. The Ccasa horizon has few to many striations and nests of salts. Buried horizons commonly are below a depth of 40 inches. In places the C horizon is stratified with layers of coarser material.

Durrstein soils are mapped with Egas soils and are similar to Hoven and Jerauld soils. They contain less salts at greater depths than Egas soils, and they differ from them in having a columnar structure in the Bt horizon. Durrstein soils have a thinner B horizon than Hoven soils and are more saline. Salts are at shallower depth in Durrstein soils than in the better drained Jerauld soils.

Durrstein and Egas soils (0 to 1 percent slopes) (Du).—These soils are on bottom lands of Okobojo and North Medicine Knoll Creeks. Areas range from ⅛ to ½ mile in width. These two soils occur in an erratic pattern. Some areas are dominantly Durrstein soils, some are mainly Egas soils, and in other areas both soils are present in different proportions. Durrstein soils commonly are at slightly higher elevations than Egas soils. The soil that has the profile described as representative for the Durrstein series is in this complex. Egas soils are in the lower, slightly depressional areas.

These soils have a water table, and they are high in salts. Thin white crusts of salts form on the surface of the Egas soils when their surface is dry.

Most of the areas are in native grass used for grazing or hay. A few small areas are in alfalfa. The stands of alfalfa are affected by the fluctuation of the water table and the presence of salts. Durrstein soils in capability unit VIw–4; Saline Lowland range site; and windbreak group 10; Egas soils in capability unit VIIs–5; Saline Lowland range site; and windbreak group 10.

Eakin Series

The Eakin series consists of deep, well-drained, nearly level to gently sloping, silty soils on uplands. These soils formed in silty material over glacial till.

In a representative profile the surface layer is dark-gray silt loam about 7 inches thick. The subsoil, about 20 inches thick, is grayish-brown silty clay loam in the upper part and calcareous, light yellowish-brown heavy silt loam in the lower part. The underlying material is calcareous, gray and grayish-brown clay loam.

Eakin soils are moderate to moderately low in content of organic matter and medium in fertility. Permeability is moderate in the surface layer and subsoil and moderately slow in the underlying material. Runoff is slow to medium. The available water capacity is high.

Many areas are cultivated. Corn, small grain, and alfalfa are the main crops. Other areas are in mid and short native grasses which are grazed.

In Sully County Eakin soils are mapped only with Agar and Highmore soils.

Representative profile of Eakin silt loam in a cultivated area of Agar-Eakin silt loams, 0 to 2 percent slopes, 550 feet west and 370 feet south of the NE. corner of sec. 16, T. 116 N., R. 77 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silt loam, dark grayish brown (10YR 4/2) crushed and very dark gray (10YR 3/1) moist; weak, fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

B2t—7 to 13 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; thin continuous clay films on faces of peds; neutral; clear, wavy boundary.

B3ca—13 to 27 inches, light yellowish-brown (2.5Y 6/3) heavy silt loam, olive brown (2.5Y 4/3) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common medium segregations of lime; calcareous; moderately alkaline; clear, wavy boundary.

IIC1ca—27 to 38 inches, gray (5Y 5/1) clay loam, olive gray (5Y 4/2) moist; common, fine, dark grayish-brown (2.5Y 4/2) and reddish-brown (5YR 4/4) mottles; weak, medium and fine segregations of lime; calcareous; strongly alkaline; gradual, wavy boundary.

IIC2—38 to 54 inches, grayish-brown (2.5Y 5/2) and dark-gray (2.5Y 4/1) clay loam, dark grayish brown (2.5Y 4/2) and very dark gray (2.5Y 3/1) moist; massive; hard, firm, sticky, plastic; calcareous; strongly alkaline; diffuse boundary.

IIC3—54 to 60 inches, grayish-brown (2.5Y 5/2) and gray (2.5Y 5/1) clay loam, dark grayish brown (2.5Y 4/2) and very dark gray (2.5Y 3/1) moist; massive; hard, firm, sticky, plastic; common gypsum crystals in nests and seams; calcareous; strongly alkaline.

The A horizon ranges from 4 to 8 inches in thickness and from dark gray to grayish brown in color. The B2t horizon ranges from dark gray to grayish brown in hue of 10YR or 2.5Y. It has weak to moderate prismatic structure. This horizon ranges from 5 to 9 inches in thickness. The B3ca horizon is light yellowish brown or light brownish gray. Texture is silty clay loam, silt loam, or clay loam. The prismatic structure in this horizon is medium or coarse. Segregations of lime in the B3ca and IIC1ca horizons range from common to many. The B3ca ranges from 10 to 15 inches in thickness. The IIC horizon is clay loam or light clay in texture and has few to common mottles of reddish brown. Depth to glacial till ranges from 20 to 40 inches, and in places the B3ca horizon formed in that material.

Eakin soils are similar to Akaska soils and are mapped with or are near Agar, Glenham, and Highmore soils. They have a more clayey C horizon than the Akaska soils, which have sand and gravel at a depth of less than 40 inches. Eakin soils formed in thinner mantles of silty material than Agar and Highmore soils, which are silty to a depth of more than 40 inches. They are more silty than Glenham soils.

Egas Series

The Egas series consists of deep, poorly drained, level, clayey soils that are high in content of salts. These soils formed in clayey alluvium on bottom lands.

In a representative profile the surface layer consists of 1 inch of gray silty clay loam over 3 inches of dark-gray silty clay. Below the surface layer is gray and light brownish-gray silty clay that is high in content of salts.

Egas soils are moderate in content of organic matter but, because of the high content of salts, are low in fertility. Permeability is slow, and runoff is slow to very slow. Available water capacity is low to moderate. The water table fluctuates between depths of 2 and 5 feet and in wet years is close to the surface early in the growing season.

All areas of these soils are in native grass used for grazing. These soils are too wet and too saline for cultivated crops.

Representative profile of Egas silty clay, in native grass, 473 feet east and 42 feet north of the SW. corner of sec. 36, T. 113 N., R. 76 W.:

A11—0 to 1 inch, gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; weak, medium, granular structure; hard, firm, sticky, plastic; moderately alkaline; clear, smooth boundary.

A12—1 to 4 inches, dark-gray (2.5Y 4/1) silty clay, black (2.5Y 2/1) moist; moderate, fine, subangular blocky structure; very hard, very firm, very sticky, plastic; moderately alkaline; clear, smooth boundary.

C1sa—4 to 19 inches, gray (2.5Y 5/1) silty clay, very dark gray (2.5Y 3/1) moist; massive; very hard, very firm, very sticky, plastic; disseminated salt and common striations of salts, and peds become encrusted with white salts when drying; calcareous; moderately alkaline; gradual, wavy boundary.

C2sa—19 to 36 inches, light brownish-gray (2.5Y 6/2) silty clay, olive brown (2.5Y 4/3) moist; massive; very hard, very firm, very sticky, plastic; disseminated salt and common striations of salts, and peds become encrusted with white salts when drying; calcareous; moderately alkaline; gradual, wavy boundary.

C3sa—36 to 60 inches, gray (5Y 5/1) silty clay, dark gray (5Y 4/1) moist; massive; very hard, very firm, very sticky, plastic; disseminated salt and common striations of salts, and peds become encrusted with white salts when drying; calcareous; moderately alkaline.

Reaction below the A horizon is moderately alkaline or strongly alkaline. Depth to lime commonly ranges from 4 to 10 inches, but in places the A horizon is calcareous. The A11 horizon is silty clay loam, silt loam, or loam and ranges from ½ inch to 2 inches in thickness. The A12 horizon is silty clay or silty clay loam and has moist colors of black or very dark gray in hue of 10YR or 2.5Y. The A12 horizon ranges from 2 to 5 inches in thickness. In the C horizon striations of salts range from few to many. In places this horizon has few, fine, faint to many, medium, distinct mottles and is stratified with coarser material below a depth of 40 inches.

Egas soils are mapped with or are near Durrstein soils. They contain more salts and lack the columnar-structured Bt horizon of the Durrstein soils. Egas soils are more clayey and more saline than Elpam soils, which also are poorly drained.

Egas silty clay (0 to 1 percent slopes) (Eg).—This soil is on bottom lands along Okobojo and North Medicine Knoll Creeks. Included in mapping were small areas of Durrstein soils on slight rises.

This soil has a high water table and is high in content of salts. Fertility is low. When the surface layer begins to dry in midsummer, a thin white layer of salts forms on the surface. The soil is too wet and too saline for cultivation.

All areas are in native vegetation used for grazing. The native vegetation consists of the more salt-tolerant grasses and forbs. Some areas have spots that are barren of vegetation. Capability unit VIIs–5; Saline Lowland range site; windbreak group 10.

Elpam Series

The Elpam series consists of deep, poorly drained, nearly level soils that are calcareous and that formed in silty sediment. These soils are in depressions and along sluggish drainageways.

In a representative profile the surface layer is gray silt loam about 4 inches thick. Below this is a transitional layer of gray silty clay loam that is soft when dry and friable when moist. It is about 11 inches thick. The underlying material is light-gray and white silty clay loam to a depth of 52 inches and light olive-brown and light-gray clay loam below that depth.

Elpam soils are moderate in content of organic matter and medium in fertility. Permeability is moderate, and runoff is slow to very slow. The available water capacity is high. Elpam soils are subject to flooding and have a water table at depths between 1½ and 4 feet. These soils are moist throughout the growing season.

Nearly all areas of these soils are used for hay or grazing.

Representative profile of Elpam silt loam, in native grass, 2,870 feet north and 1,430 feet west of the SE. corner of sec. 2, T. 116 N., R. 74 W.:

A1—0 to 4 inches, gray (10YR 5/1) silt loam, black (10YR 2/1) moist; weak, medium, granular structure; soft, very friable; calcareous; moderately alkaline; clear, wavy boundary.

ACca—4 to 15 inches, gray (N/0 and 2.5Y 5/1) silty clay loam, dark gray (2.5Y 4/1) and very dark gray (5Y 3/1) moist; very weak, medium, prismatic structure parting to weak, fine, granular structure; soft, friable, slightly sticky; calcareous; moderately alkaline; clear, wavy boundary.

C1ca—15 to 36 inches, light-gray (N 7/0) silty clay loam, gray (5Y 5/1) moist; massive; hard, firm, slightly sticky; calcareous; moderately alkaline; gradual, wavy boundary.

C2ca—36 to 52 inches, white (5Y 8/1) silty clay loam, gray (5Y 5/1) moist; massive; hard, firm, slightly sticky; calcareous; moderately alkaline; clear, smooth boundary.

IIC3—52 to 60 inches, light olive-brown (2.5Y 5/4) and light-gray (5Y 7/1) clay loam, olive brown (2.5Y 4/4) and gray (5Y 5/1) moist; massive; hard, firm, slightly sticky; calcareous; moderately alkaline.

The A horizon, when moist, ranges from black to dark gray in hues of 10YR and 2.5Y or the color is neutral. It is silt loam or silty clay loam and ranges from 3 to 6 inches in thickness. The AC horizon is silty clay loam or silt loam and has very weak or weak prismatic structure. It ranges from 3 to 12 inches in thickness. Either clay loam glacial till or sand commonly is at depths between 40 and 60 inches, but in places the C horizon is silty to a depth of 60 inches or more.

Elpam soils are near Durrstein and Egas soils. They lack the clayey B horizon of the Durrstein soils, and the C horizon is clayey and contains less salts than that of the Egas soils.

Elpam silt loam (0 to 1 percent slopes) (Ep).—This soil is on lowlands adjacent to Stone Lake. Its profile is the one described as representative for the series, but in places the surface layer is about 8 inches thick.

Permeability is moderate and runoff is slow. Available water capacity is high, and fertility is medium. This soil is moist throughout the growing season because the water table is high. The main concern in management is wetness.

Almost all the acreage is in native grass used for hay or grazing. If adequately drained, this soil can be cultivated. Capability unit IVw–1; Subirrigated range site; windbreak group 10.

Gettys Series

The Gettys series consists of deep, excessively drained, undulating to hilly, loamy soils on uplands. These soils formed in loamy to clayey glacial till.

In a representative profile (fig. 7) the surface layer is dark grayish-brown clay loam about 3 inches thick. Below this is a transitional layer of calcareous, grayish-brown clay loam about 7 inches thick. It is hard when dry and friable when moist. The underlying material is calcareous, light brownish-gray and light olive-brown clay loam to a depth of 38 inches. Below this is calcareous, light brownish-gray and gray clay.

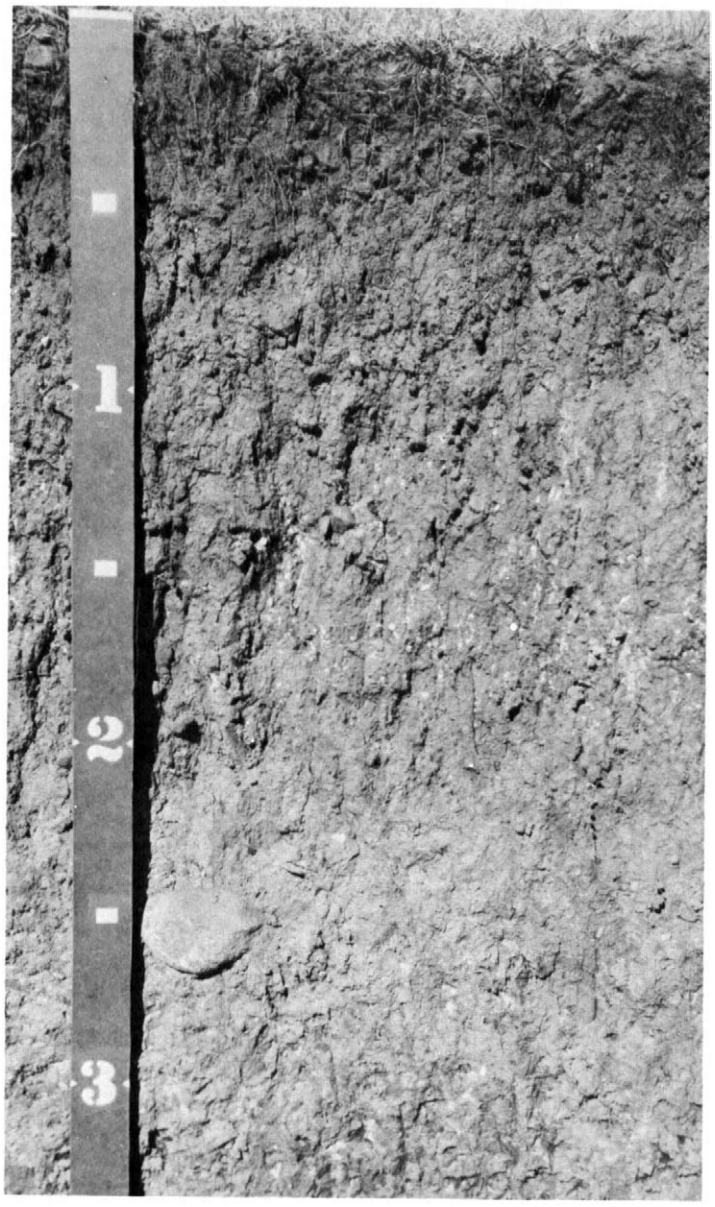


Figure 7.—**Profile of Gettys clay loam, 6 to 25 percent slopes. Spots of segregated lime are concentrated in the 10- to 22-inch layer.**

Gettys soils are moderately low to low in content of organic matter and low in fertility. Permeability is moderate in the surface layer and subsoil and moderately slow in the underlying material. Runoff is rapid. The available water capacity is moderate to high.

Almost all the acreage is in mid and short native grasses used for grazing.

Representative profile of Gettys clay loam, 6 to 25 percent slopes, in native grass, 650 feet east and 338 feet south of the NW. corner of sec. 16, T. 114 N., R. 80 W.:

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist and very dark grayish brown (10YR 3/2) crushed and moist; weak, very fine, granular structure; hard, friable; slightly sticky, slightly plastic; mildly alkaline; clear, wavy boundary.

AC—3 to 10 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure parting to weak, medium and fine, subangular blocky structure; hard, friable; slightly sticky, slightly plastic; calcareous; moderately alkaline; clear, wavy boundary.

C1ca—10 to 22 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common, fine, light yellowish-brown (2.5Y 6/3) mottles; very weak, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; few dark-gray (5Y 4/1) fragments of shale; common medium and coarse segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2cs—22 to 38 inches, light brownish-gray (2.5Y 6/2) and light olive-brown (2.5Y 5/3) clay loam, dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/3) moist; weak, medium and coarse, subangular blocky structure; hard, friable, sticky, plastic; common dark-gray (5Y 4/1) fragments of shale; few, coarse, reddish-yellow (5YR 6/8) iron concretions; many striations and nests of salts and gypsum; calcareous; moderately alkaline; irregular, wavy boundary.

C3—38 to 60 inches, light brownish-gray (2.5Y 6/2) and gray (5Y 5/1) clay, dark grayish brown (2.5Y 4/2) and very dark gray (5Y 3/1) moist; weak, coarse, subangular blocky structure; very hard, firm, sticky, plastic; many prominent pressure faces on blocks; few to common gray (5Y 5/1) fragments of shale; few coarse nests of gypsum; calcareous; moderately alkaline.

Few to common coarse fragments of gravel and cobblestones are throughout the profile. The A horizon ranges from 2 to 4 inches in thickness and is dark grayish brown or grayish brown in hue of 10YR or 2.5Y. In places this horizon is calcareous. The AC horizon is grayish brown or light brownish gray in hue of 10YR or 2.5Y. It ranges from 5 to 10 inches in thickness. The C horizon is massive in places.

Gettys soils are near Betts, Oko, Peno, and Raber soils. They are more clayey than Betts soils, and they lack the Bt horizon of the Oko, Peno, and Raber soils. They are less clayey than Oko soils.

Gettys clay loam, 6 to 25 percent slopes (GeE).—This undulating to hilly soil is on valley sides along Okobojo Creek and Lake Oahe. Slopes are medium to short in length and convex in shape. Some areas have few to many stones and cobblestones on and near the crests of ridges.

Included with this soil in mapping were areas of Betts, Oko, Peno, and Raber soils. Betts soils are in spots where the underlying glacial till is less clayey, and Oko soils are where the till is more clayey. Peno soils are on side slopes below the Gettys soils, and Raber soils are on foot slopes. Inclusions make up about 20 percent of any mapped area.

Runoff is rapid. Content of organic matter is moderately low to low, and fertility is low. The control of erosion is the main concern in management.

Almost all the acreage is in native grass used for grazing. Capability unit VIe–3; Thin Upland range site; windbreak group 10.

Glenham Series

The Glenham series consists of deep, well-drained, nearly level to undulating, loamy soils on uplands. These soils formed in friable glacial till.

In a representative profile (fig. 8) the surface layer is

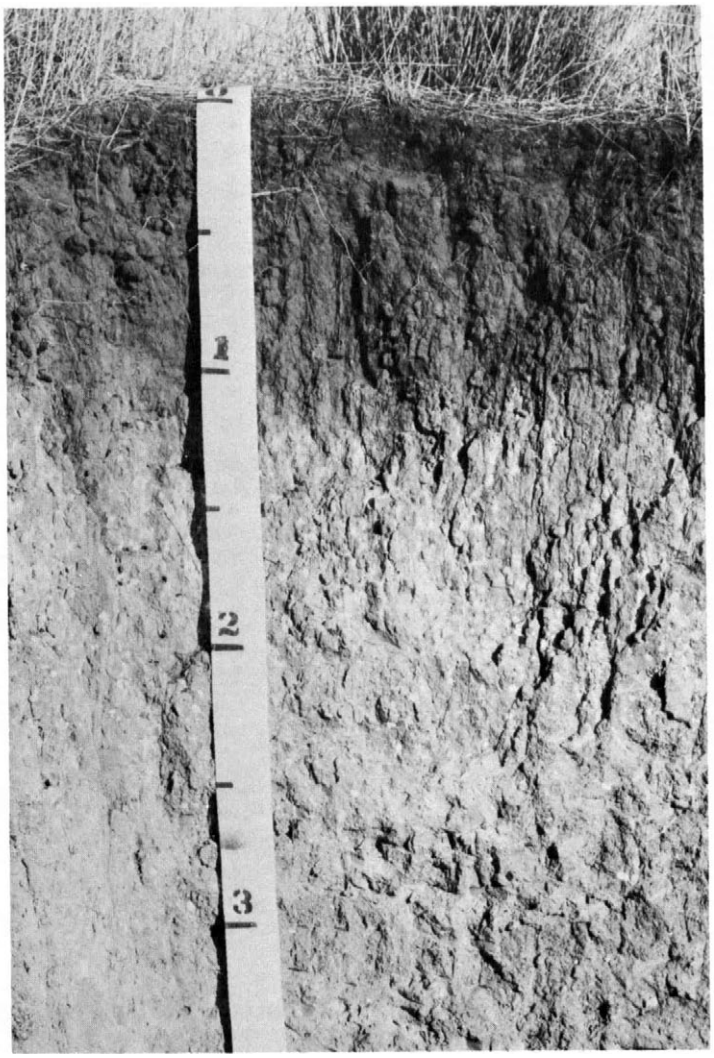


Figure 8.—**Profile of Glenham loam, 3 to 6 percent slopes. Dark-colored layers to a depth of about 13 inches are the surface layer and the upper part of the subsoil.**

dark-gray loam about 3 inches thick. The subsoil, about 15 inches thick, is clay loam that is dark grayish brown in the upper part and grayish brown in the lower part. It is hard when dry and friable when moist. The lower part is calcareous. The underlying material is calcareous, light brownish-gray clay loam.

Glenham soils are moderate in content of organic matter and medium in fertility. Permeability is moderate in the surface layer and subsoil and moderately slow in the underlying material. Runoff is slow to medium. The available water capacity is high.

About 50 percent of the areas are cultivated. The rest is in mid and short native grasses used for grazing and hay. Corn, small grain, and alfalfa are the main crops.

Representative profile of Glenham loam, 3 to 6 percent slopes, in native grass, 790 feet east and 112 feet north of the SW. corner of sec. 2, T. 114 N., R. 74 W.:

A1—0 to 3 inches, dark-gray (10YR 4/1) loam, dark grayish-brown (10YR 4/2) crushed and very dark gray (10YR 3/1) moist; weak, medium, granular structure; soft, very friable; neutral; clear, wavy boundary.

B21t—3 to 9 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; thin patchy clay films on vertical faces of peds; neutral; clear, wavy boundary.

B22t—9 to 13 inches, dark grayish-brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) crushed and very dark grayish brown (10YR 3/2) moist and dark grayish brown (10YR 4/2) crushed and moist; weak, medium and fine, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; thin patchy clay films on all faces of peds; mildly alkaline; clear, wavy boundary.

B3ca—13 to 18 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; few fine segregations of lime; calcareous; moderately alkaline; clear, wavy boundary.

C1ca—18 to 38 inches, light brownish-gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/3) moist; weak, coarse, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common fine segregations of lime; calcareous; moderately alkaline; clear, wavy boundary.

C2—38 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/3) with few, fine, gray (5Y 5/1) mottles moist; massive; slightly hard, friable, slightly sticky, slightly plastic; few fine nests of gypsum crystals; few fine segregations of lime; calcareous; moderately alkaline.

Depth to lime ranges from 10 to 16 inches. A few pebbles commonly are distributed throughout the profile. The A horizon ranges from 3 to 6 inches in thickness and from very dark gray to grayish brown in color. Texture is loam or silt loam. The B2t horizon commonly is clay loam, but in places it is loam or silty clay loam. The C horizon is clay loam or loam and commonly has small pockets or thin lenses of gravel.

Glenham soils are near or are mapped with Betts, Java, and Raber soils. They have a thicker B horizon and are deeper to lime than Betts and Java soils. Glenham soils contain less clay in the B horizon than Raber soils.

Glenham loam, 0 to 3 percent slopes (GlA).—This soil is on uplands in the eastern part of the county. Its profile is similar to the one described as representative for the series, but the surface layer is thicker where the soil is more nearly level.

Included with this soil in mapping were areas of Hoven and Onita soils. The Hoven soils are in small, closed depressions, usually less than 2 acres in size; and the Onita soils are in swales. Inclusions make up less than 15 percent of any mapped area.

Tilth is good, and this soil is easy to work. Runoff is

slow, and available water capacity is high. Conservation of moisture is the main concern in management. Also, management is needed to control soil blowing and to maintain tilth, content of organic matter, and fertility.

Corn, small grain, and alfalfa are the main crops in cultivated areas. Many areas are in native grass used for grazing and hay. Capability unit IIc–2; Silty range site; windbreak group 3.

Glenham loam, 3 to 6 percent slopes (GlB).—Slopes of this gently undulating soil are short, convex, and irregular. This soil has the profile described as representative for the series. Eroded spots are in cultivated areas. The soil material is lighter in color in these spots and the surface layer is clay loam. Many areas have a few stones on the surface, but not enough to make tillage impractical.

Included with this soil in mapping were areas of Hoven, Java, and Onita soils. The Hoven soils are in closed depressions that are less than 2 acres in size. The Java soils are on or just below the crests of ridges and knolls. The Onita soils are in swales.

Runoff is medium, and the soil is susceptible to water erosion and soil blowing. The control of water erosion and soil blowing is the main concern in management. Also, management is needed to conserve moisture and to maintain tilth, content of organic matter, and fertility.

Corn, small grain, alfalfa, and tame grasses are the main crops in cultivated areas. Many areas are in native grass used for grazing and hay. Capability unit IIe–2; Silty range site; windbreak group 3.

Glenham loam, 6 to 9 percent slopes (GlC).—Slopes of this undulating soil are short, convex, and irregular. In many areas few to common stones are on the surface. This soil has a profile similar to the one described as representative for the series, except that the subsoil is thinner and the depth to lime is 10 to 12 inches. Also, in cultivated areas there are spots where the surface layer has eroded away or has been mixed with the subsoil by plowing.

Included with this soil in mapping were areas of Eakin and Java soils. Eakin soils are on the longer and smoother side slopes. Java soils are just below or on the tops of ridges and knolls. They commonly are marked by few to common stones on the surface.

Runoff is medium. Control of water erosion and control of soil blowing are the main concerns in management. Also, management is needed to conserve moisture and to maintain tilth, content of organic matter, and fertility.

Many areas are in native grass used for grazing. Corn, small grain, alfalfa, and tame grass are the main crops in cultivated areas. Capability unit IIIe–2; Silty range site; windbreak group 3.

Highmore Series

The Highmore series consists of deep, well-drained, nearly level to undulating, silty soils on uplands. These soils formed in silty glacial drift.

In a representative profile the surface layer is dark-gray silt loam about 7 inches thick. The subsoil, about 18 inches thick, is silty clay loam. It is dark grayish brown in the upper part, grayish brown in the middle, and light yellowish brown in the lower part. The subsoil is hard when dry and friable when moist. The lower part of the subsoil is calcareous. The underlying material is calcareous, light yellowish-brown silt loam.

Highmore soils are moderate in content of organic matter and medium in fertility. Runoff is slow to medium, and permeability is moderate. The available water capacity is high.

Many areas are cultivated. Small grain, corn, and alfalfa are the main crops. Some areas are in native grass used for grazing and hay.

Representative profile of Highmore silt loam in an area of Highmore-Eakin silt loams, 0 to 2 percent slopes, 1,555 feet north and 80 feet east of the SW. corner of sec. 30, T. 114 N., R. 76 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak, medium, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

B21t—7 to 12 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark gray (10YR 3/1) moist and very dark grayish brown (10YR 3/2) crushed and moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; thin continuous clay films on faces of peds; neutral; clear, smooth boundary.

B22t—12 to 17 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; thin patchy clay films on faces of peds; mildly alkaline; clear, smooth boundary.

B3ca—17 to 25 inches, light yellowish-brown (2.5Y 6/3) silty clay loam, light olive brown (2.5Y 5/3) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common medium and fine segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—25 to 40 inches, light yellowish-brown (2.5Y 6/3) silt loam, light olive brown (2.5Y 5/3) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; few medium segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2—40 to 49 inches, light yellowish-brown (2.5Y 6/3) silt loam, light olive brown (2.5Y 5/3) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; few fine and few medium concretions of lime; calcareous; moderately alkaline; clear, smooth boundary.

C3—49 to 60 inches, light yellowish-brown (2.5Y 6/3) silt loam, light olive brown (2.5Y 5/3) moist; common, medium, light-gray (2.5Y 7/1) mottles; massive; slightly hard, friable; calcareous; moderately alkaline.

Few to common granitic pebbles, some as large as 1 inch in diameter, are throughout the profile. Depth to lime ranges from 12 to 26 inches. The A horizon ranges from 5 to 8 inches in thickness and from very dark gray to grayish brown in color. The B horizon has weak or moderate prismatic structure. The B2t horizon ranges from 7 to 18 inches in thickness. The C horizon ranges from very fine sandy loam to silty clay loam in texture. Below a depth of 36 inches, this horizon generally has very thin lenses of sand and silt. These stratified materials commonly extend to a depth of 5 feet or more, but in places clay loam glacial till is between depths of 40 and 60 inches.

Highmore soils resemble Agar soils. They are mapped in complexes with DeGrey, Eakin, Raber, and Walke soils. Highmore soils contain more sand than Agar soils; and, unlike Agar soils, they have a thinly stratified C horizon. Highmore soils have a less clayey B horizon than soils of the DeGrey, Raber, and Walke series. They are silty to a greater depth than Eakin soils.

Highmore silt loam, 0 to 2 percent slopes (HcA).—This soil is on uplands in the eastern part of the county. Included in mapping were areas of Eakin soils on low, convex-shaped rises and Onita soils in swales.

Tilth is good, and the soil is easy to work. The available water capacity is high. Runoff is slow. Conservation of moisture is the main concern in management. Also, management is needed to control soil blowing and to maintain tilth, content of organic matter, and fertility.

Most areas are cultivated. Corn, small grain, and alfalfa are the main crops. Capability unit IIc–2; Silty range site; windbreak group 3.

Highmore-DeGrey silt loams, 0 to 2 percent slopes (HdA).—Highmore soils make up 60 percent of this complex; DeGrey soils, 30 percent; and other soils, 10 percent. Highmore soils have a profile similar to that described as representative for their series, except that clay loam glacial till is generally in the underlying material at a depth of about 46 inches. DeGrey soils are in slight depressions.

Included with this soil in mapping were areas of Walke soils that are level to slightly depressional. They are commonly in a close pattern with the DeGrey soils.

Runoff is slow, and the erosion hazard is slight. The available water capacity is moderate to high. Permeability is slow or very slow in DeGrey soils, however, and their claypan subsoil releases moisture slowly to plants. Crops grow unevenly in DeGrey soils, and these soils are generally poor in tilth and difficult to work. The main concerns in management are conservation of moisture and, in DeGrey soils, improvement in tilth and intake of water. Other general management needs are control of soil blowing, maintenance of fertility, and content of organic matter.

About 50 percent of this complex is cultivated. Other areas are in native grass used for grazing and hay. Corn, small grain, and alfalfa are the main crops. Capability unit IVs–2. Highmore soils in Silty range site and windbreak group 3. DeGrey soils in Claypan range site and windbreak group 9.

Highmore-Eakin silt loams, 0 to 2 percent slopes (HeA).—Highmore soils make up 45 to 65 percent of this complex; Eakin soils, 20 to 40 percent; and other soils, about 15 percent. Eakin soils are on slight rises. The Highmore soil that has the profile described as representative for the series is in this complex.

Included with these soils in mapping were areas of Hoven, Onita, and Raber soils. Hoven soils are in small, closed depressions. Onita soils are in swales and in slight depressions. Raber soils are on convex rises.

The soils in this complex have good tilth and are easy to work. The available water capacity is high. Runoff is slow, and the erosion hazard is slight. Conservation of moisture is the main concern in management. Other management needs are control of soil blowing and maintenance of tilth, content of organic matter, and fertility.

Most areas are cultivated. Corn, small grain, and alfalfa are the main crops. A few areas are in native grass, which is used for grazing and hay. Capability unit IIc–2; Silty range site; windbreak group 3.

Highmore-Eakin silt loams, 2 to 5 percent slopes (HeB).—Highmore soils make up about 45 percent of this complex; Eakin soils, 40 percent; and other soils, 15 percent. Single slopes are gently sloping, and complex slopes are gently undulating. Highmore soils are on the smooth side slopes. Their profile is similar to the one described as representative for their series, except that the surface layer is thinner and the depth to lime is generally about 14 inches. Eakin soils are on the higher parts of the landscape.

Included with these soils in mapping were areas of Hoven, Onita, and Raber soils. Hoven soils are in closed depressions; Onita soils are in swales; and Raber soils, the ones most commonly included, are intermingled with Eakin soils in areas where the underlying glacial till is more clayey.

These soils have good tilth and are easy to work. Runoff is medium. Control of water erosion and soil blowing are the main concerns in management. Also, management is needed to conserve moisture and to maintain tilth, content of organic matter, and fertility.

Many areas are cultivated. Other areas are in native grass and are used for grazing and hay. Corn, small grain, and alfalfa are the main crops in cultivated areas. Capability unit IIe–1; Silty range site; windbreak group 3.

Highmore-Walke silt loams, 0 to 2 percent slopes (HmA).—Highmore soils make up 30 to 55 percent of this complex; Walke soils, 20 to 40 percent; and other soils, 15 to 35 percent. The very slight rises are broken by numerous level or slightly depressional areas. Highmore soils are on the well-drained rises. Their profile is similar to the one described as representative for their series, except that the underlying material is commonly clay loam between depths of 40 and 60 inches. Walke soils are in the slightly depressional areas. The Walke soil that has the profile described as representative for the series is in this complex.

Included with these soils in mapping were areas of Cavo, Eakin, Onita, and Raber soils. Eakin soils are the most common inclusion, and in places they make up as much as 30 percent of the mapped area. They are on slight rises and are intermingled with Highmore soils. Onita soils are in swales, and Raber soils are on some of the rises. Cavo soils are in depressional areas near Raber soils.

Runoff is slow, and the erosion hazard is slight. The available water capacity is moderate to high, but the clayey subsoil in Walke soil releases moisture slowly to plants. Tilth deteriorates easily in the Walke soil. Conservation of moisture and improvement of tilth and intake of water in the Walke soil are concerns in management. Also, management is needed to control soil blowing and to maintain content of organic matter and fertility.

About half the acreage is cultivated. The rest is in native grass used for grazing and hay. Corn, small grain, and alfalfa are the main crops. Capability unit IIc–2; Highmore soils in Silty range site and windbreak group 3; Walke soils in Clayey range site and windbreak group 4.

Hoven Series

The Hoven series consists of deep, poorly drained, level soils that have a claypan subsoil. These soils formed in

alluvium washed from adjacent soils. They are in depressions on uplands.

In a representative profile the surface layer is gray silt loam about 4 inches thick. The subsoil, about 26 inches thick, is dark-gray silty clay. The upper part is extremely hard when dry and very firm when moist. The underlying material is calcareous, grayish-brown clay loam.

Hoven soils are moderate in content of organic matter and medium in fertility. They are ponded and subject to flooding. Permeability is very slow, and available water capacity is moderate to high.

Most areas are in native grass used for grazing and hay. In places areas of Hoven soils in cultivated fields are farmed along with other soils as a matter of convenience.

Representative profile of Hoven silt loam in native grass, 1,290 feet north and 320 feet west of the SE. corner of sec. 16, T. 114 N., R. 78 W.:

A2—0 to 4 inches, gray (10YR 6/1) silt loam, very dark gray (10YR 3/1) moist; weak, fine, platy structure; soft, very friable; neutral; abrupt, wavy boundary.

B21t—4 to 7 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; thin, continuous, gray (10YR 6/1) coatings on tops of columns and thin patchy coatings on vertical faces of peds; strong, coarse, columnar structure parting to strong, medium, blocky structure; extremely hard, very firm, sticky, plastic; thin patchy clay films on faces of peds; mildly alkaline; gradual, wavy boundary.

B22t—7 to 18 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; weak, coarse, prismatic structure parting to strong, medium and fine, blocky structure; extremely hard, very firm, sticky, plastic; thin continuous clay films on faces of peds; mildly alkaline; gradual, wavy boundary.

B3—18 to 30 inches, dark-gray (2.5Y 4/1) silty clay, very dark grayish brown (2.5Y 3/2) moist; weak, coarse, subangular blocky structure; very hard, firm, sticky, plastic; very few fine segregations of lime; moderately alkaline; clear, wavy boundary.

C1ca—30 to 46 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few, fine, distinct, gray (5Y 5/1) mottles; massive; hard, friable, slightly sticky, slightly plastic; few fine masses and striations of segregated lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2—46 to 60 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, friable, slightly sticky, slightly plastic; few fine nests of gypsum crystals and other salts; calcareous; moderately alkaline.

The A2 horizon is gray or light gray. This horizon ranges from 2 to 6 inches in thickness. It has weak to moderate, fine or medium, platy structure. In places a thin, darker colored A1 horizon is above the A2 horizon. The B horizon is dark gray or gray and has a hue of 10YR or 2.5Y. Texture is heavy silty clay loam, silty clay, or clay. The B21t horizon ranges from 2 to 6 inches in thickness and has moderate to strong, medium or coarse, columnar structure. In places the B3 horizon is calcareous. Segregations of lime are very few to common in the B3 and C1ca horizons. The C horizon is commonly clay loam or silty clay loam but in places is clay or silty clay. Nests of gypsum crystals in the C horizon are few to common.

Hoven soils are near Agar, Glenham, Highmore, and Raber soils. They have a more clayey B horizon than those soils. Hoven soils have salts at greater depths than Durrstein soils, and they are more poorly drained than Cavo and DeGrey soils.

Hoven silt loam (0 to 1 percent slopes) (Ho).—This soil is in closed depressions on uplands. Areas are oval to circular in shape. They commonly are about 5 to 10 acres in size but range from 2 to 500 acres.

Permeability is very slow. This soil is ponded in places, and in wet years it is flooded during much of the growing season. If cultivated, this soil has poor tilth and is difficult to work. The main concerns in management are poor tilth, slow intake of water into the claypan subsoil, and wetness.

Most areas are in native grass used for hay or grazing. In places areas are cultivated, but crops are flooded. Capability unit VIs–1; Closed Depression range site; windbreak group 10.

Hurley Series

The Hurley series consists of moderately well drained, nearly level to gently sloping, silty soils that have a claypan subsoil and are moderately deep over shale. These soils formed in weathered clayey materials either in place or washed in from adjacent slopes.

In a representative profile the surface layer is gray silt loam about 3 inches thick. The subsoil, about 16 inches thick, is silty clay that is dark gray in the upper part and grayish brown in the lower part. It is extremely hard when dry and very firm when moist. The lower part of the subsoil is calcareous. The underlying material, to a depth of 32 inches, is calcareous, dark grayish-brown and olive-gray silty clay that contains gypsum crystals and fragments of shale. Below a depth of 32 inches is light olive-gray soft shale.

Hurley soils are moderately low in content of organic matter and low in fertility. Permeability is very slow, and runoff is slow to medium. Available water capacity is low to very low.

Almost all areas are in native grass used for grazing.

Representative profile of Hurley silt loam, 0 to 5 percent slopes, in native grass, 1,150 feet south and 670 feet west of the NE. corner of sec. 11, T. 116 N., R. 79 W.:

A2—0 to 3 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak, fine, platy structure parting to weak, fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

B2t—3 to 10 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; strong, coarse, columnar structure parting to moderate, medium, subangular blocky structure; extremely hard, very firm, sticky, plastic; moderately alkaline; clear, smooth boundary.

B3ca—10 to 19 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; extremely hard, very firm, sticky, plastic; few medium segregations of lime; calcareous; moderately alkaline; clear, smooth boundary.

C1cs—19 to 25 inches, dark grayish-brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate, medium and fine, subangular blocky structure; extremely hard, very firm, sticky, plastic; common fine nests of gypsum crystals; calcareous; moderately alkaline; gradual, smooth boundary.

C2cs—25 to 32 inches, olive-gray (5Y 4/2) silty clay, dark olive gray (5Y 3/2) moist; massive; extremely hard, very firm, sticky, plastic; fine fragments of shale make up 25 to 35 percent, by volume; common fine nests of gypsum crystals; calcareous; moderately alkaline; gradual, wavy boundary.

C3—32 to 60 inches, light olive-gray (5Y 6/2) soft shale, olive gray (5Y 5/2) moist; bedded; strongly alkaline.

Depth to shale commonly is between 30 and 40 inches. In places there is an A1 horizon 1 to 2 inches thick. The A2 horizon ranges from 1 to 4 inches in thickness. Texture is silt loam or silty clay loam and color is gray or light gray in hue of 10YR, 2.5Y, or 5Y. The B2t horizon ranges from 4 to 8 inches in thickness and is silty clay or clay. Segregations of lime in the B3ca horizon are few to common. The C horizon, above the bedded shale, ranges from silty clay loam to clay and has few to common segregations of gypsum and other salts.

Hurley soils have a columnar-structured B horizon that contains more sodium than the nearby soils of the Oko, Opal, and Promise series. They resemble Durrstein soils but are better drained, have salts deeper in the profile, and are moderately deep over shale.

Hurley silt loam, 0 to 5 percent slopes (HuA).—This soil is along drainageways and on foot slopes on uplands in the western part of the county. The plane to concave slopes are uneven because they have depressions that are one to several feet in diameter and 2 to 6 inches deep.

Included with this soil in mapping were areas of DeGrey, Oko, and Opal soils and Saline and alkali land. DeGrey and Oko soils are on the edges of some of the areas. Opal soils are the most common and make up about 15 percent of the areas mapped. They are on slight rises. Saline and alkali land is in some of the depressions.

Runoff is slow in nearly level areas and medium in gently sloping areas. Permeability is very slow, and the claypan subsoil at shallow depths limits the intake of water and the development of plant roots.

Nearly all areas are in native grass used for grazing. The soil is not suited to cultivation. Capability unit VIs–1; Thin Claypan range site; windbreak group 10.

Java Series

The Java series consists of deep, well-drained, gently undulating to rolling, loamy soils on uplands. These soils formed in friable glacial till.

In a representative profile (fig. 9) the surface layer is gray loam about 3 inches thick. The subsoil, about 9 inches thick, is light clay loam that is grayish brown in the upper part and light brownish gray in the lower part. It is slightly hard when dry and friable when moist. The lower part of the subsoil is calcareous. The underlying material is calcareous, light yellowsh-brown and light brownish-gray light clay loam.

Java soils are moderate to moderately low in content of organic matter and medium to low in fertility. Permeability is moderate in the surface layer and subsoil and moderately slow in the underlying material. Runoff is medium. The available water capacity is high.

Many areas are in native grass used for grazing or hay. A few areas are cultivated. Small grain, sorghum, and alfalfa are the main crops.

Representative profile of Java loam in native grass in an area of Java-Glenham loams, 3 to 9 percent slopes, 593 feet east and 596 feet south of the NE. corner of sec. 14, T. 113 N., R. 74 W.:

A1—0 to 3 inches, gray (10YR 5/1) loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

Figure 9.—**Profile of Java loam from an area of Java-Glenham loams, 3 to 9 percent slopes. Lime accumulations are at a depth of about 8 inches.**

B2—3 to 8 inches, grayish-brown (10YR 5/2) light clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky; thin patchy clay films on vertical faces of peds; neutral; clear, wavy boundary.

B3ca—8 to 12 inches, light brownish-gray (2.5Y 6/2) light clay loam, grayish brown (2.5Y 5/2) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky; few medium segregations of lime; calcareous; mildly alkaline; gradual, wavy boundary.

C1ca—12 to 40 inches, light yellowish-brown (2.5Y 6/3) light clay loam, light olive brown (2.5Y 5/3) moist; very weak, coarse, subangular blocky structure to massive; slightly hard, friable, slightly sticky; common fine and medium segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2—40 to 60 inches, light brownish-gray (2.5Y 6/2) light clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, slightly sticky; few fine iron stains of yellowish red (5YR 5/8) moist; calcareous; mildly alkaline.

Depth to lime ranges from 6 to 10 inches. The A horizon ranges from 2 to 4 inches in thickness and from dark gray to grayish brown in color. The B2 horizon ranges from dark grayish brown to brown in hues of 10YR and 2.5Y. Texture is light clay loam or loam, and thickness ranges from 4 to 6 inches. The C horizon is light clay loam or loam.

Java soils are mapped in complexes with Betts and Glenham soils. When moist, Java soils are very dark grayish brown or darker to a greater depth than are Betts soils. Java soils have thinner A and B horizons than Glenham soils and are not so deep to lime.

Java-Betts loams, 6 to 15 percent slopes (JbD).—The soils in this complex are undulating to rolling. Java soils make up 45 to 65 percent of the complex; Betts soils, 20 to 40 percent; and other soils, about 15 percent. Most areas are on valley sides along Okobojo and North Medicine Knoll Creeks. Slopes are short and convex. Java soils are in the middle and lower parts of the landscape. Betts soils are on or just below the crest of slopes. In places a few stones are on the surface of the Betts soils.

Included with these soils in mapping were areas of Glenham, Onita, Peno, and Ree soils. Glenham soils are intermingled with Java soils. Peno soils are in places where the underlying material is more clayey. Onita and Ree soils are on foot slopes and in swales.

Runoff is medium or rapid, and the soils are erodible. The content of organic matter is moderately low or low, and fertility is low. Control of erosion is the main concern in management.

Most areas are in native grass used for grazing and hay. A few areas are cultivated. Capability unit VIe–3. Java soils in Silty range site and windbreak group 3. Betts soils in Thin Upland range site and windbreak group 10.

Java-Betts stony complex, 3 to 12 percent slopes (JcD).—The soils in this complex are gently undulating to rolling. Java soils make up 40 to 55 percent of the complex; Betts soils, 30 to 45 percent; and other soils, about 15 percent. Slopes are short, convex, and irregular. Java soils are on the side slopes. Betts soils are on the tops of ridges and knolls or just below. A few stones are on the surface of the Java soils, but stones are common to many on the surface of the Betts soils.

Included with these soils in mapping were areas of Glenham and Raber soils in the lower parts of side slopes.

Runoff is medium or rapid. Control of erosion and stoniness are concerns in management.

Nearly all areas are in native grass used for grazing. Capability unit VIIs–6; Java soils in Silty range site and windbreak group 3; Betts soils in Thin Upland range site and windbreak group 10.

Java-Glenham loams, 3 to 9 percent slopes (JgC).—The soils in this complex are gently undulating and undulating. Java soils make up about 45 to 60 percent of the complex; Glenham soils, 35 to 50 percent; and other soils, about 5 percent. Slopes are short and complex. Java soils are on the tops of ridges and the upper parts of side slopes. They have the profile described as representative for their series, except that in eroded areas in cultivated fields, the surface layer is lighter colored and calcareous. Glenham soils are in the middle and lower parts of the landscape where the slopes are somewhat longer and more gentle.

Included with these soils in mapping were areas of Betts and Peno soils. Betts soils are on the crests of some ridges. Peno soils are in places where the underlying material is more clayey.

Runoff is medium, and the soils are erodible. The content of organic matter is moderate to moderately low. Control of erosion and the conservation of moisture are concerns in management. Other management needs are the control of soil blowing and the improvement of organic-matter content and fertility.

Many areas are in native grass used for grazing and hay. Small grain, sorghum, and alfalfa are the main cultivated crops. Capability unit IVe–3; Silty range site; windbreak group 3.

Jerauld Series

The Jerauld series consists of deep, somewhat poorly drained, level, loamy soils that have a claypan subsoil. These soils are in shallow depressions on uplands. They formed in glacial till or in clayey alluvium underlain by glacial till.

In a representative profile the surface layer is gray loam about 3 inches thick. The subsoil, about 13 inches thick, is dark-gray clay in the upper part and grayish-brown silty clay in the lower part. The upper part is very hard when dry and very firm when moist, and the lower part is calcareous. The underlying material is calcareous silty clay that contains nests of gypsum crystals. It is grayish brown in the upper part and olive gray below a depth of 38 inches.

Jerauld soils are moderate in content of organic matter and low in fertility. Runoff is slow, and permeability is slow to very slow. Available water capacity is low to moderate.

Almost all areas are in native grass used for grazing or hay.

Representative profile of Jerauld loam in native grass in an area of Jerauld-Demky loams, 0 to 1 percent slopes, 1,814 feet south and 572 feet east of the NW. corner of sec. 9, T. 115 N., R. 78 W.:

A2—0 to 3 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak, fine, platy structure parting to weak, fine, granular structure; slightly hard, friable, slightly sticky, slightly plastic; neutral; abrupt, smooth boundary.

B21t—3 to 5 inches, dark-gray (10YR 4/1) clay, black (10YR 2/1) moist; thin, continuous, gray (10YR 5/1) coatings on tops of columns; moderate, medium, columnar structure parting to strong, medium and fine, blocky structure; very hard, very firm, sticky, plastic; mildly alkaline; gradual, smooth boundary.

B22t—5 to 9 inches, dark-gray (10YR 4/1) clay, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, medium and fine, blocky structure; very hard, very firm, sticky, plastic; moderately alkaline; irregular, wavy boundary.

B3ca—9 to 16 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to moderate, medium and fine, blocky structure; hard, firm, sticky, plastic; few fine segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C1cacs—16 to 38 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky, plastic; common fine nests of gypsum crystals; few fine segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2cs—38 to 60 inches, olive-gray (5Y 5/2) silty clay, dark olive gray (5Y 3/2) moist; massive; hard, firm, sticky, plastic; common fine fragments of weathered shale; common fine nests of gypsum crystals; calcareous; strongly alkaline.

The A2 horizon is gray or light gray in hue of 10YR or 2.5Y. It ranges from loam to clay loam or silty clay loam in texture and from 1 to 3 inches in thickness. In places a thin A1 horizon, 1 to 2 inches thick, is above the A2 horizon. The columnar structure of the B21t horizon ranges from weak to moderate in grade and from medium to coarse in size. The B3ca and C horizons are silty clay, clay, or clay loam. In places nests of gypsum crystals and other salts are in the B3ca horizon and in the C horizon.

Jerauld soils are near Cavo soils or are mapped in complexes with Demky soils. They have thinner A and B horizons than Cavo and Demky soils. In addition they have columnar structure, which Demky soils do not have.

Jerauld-Demky loams, 0 to 1 percent slopes (JkA).—Jerauld soils make up 45 to 65 percent of this complex; Demky soils, 20 to 40 percent; and other soils, about 15 percent. The surface is uneven in the nearly flat areas. Jerauld soils are in the lower areas, and Demky soils are only a few inches higher. The soil that has the profile described as representative for the Jerauld series is in this complex. The Demky soils have a more clayey subsoil than that of the profile described as representative for the Demky series.

Included with these soils in mapping were areas of Cavo, Hoven, and Oko soils. Cavo and Oko soils are on some of the slight rises. Hoven soils are in some of the low areas.

Runoff is slow. Permeability is slow or very slow, and the claypan subsoil releases moisture slowly to plants. Tilth is poor. The main concerns in management are improving and increasing the intake of water.

Most areas are in native grass used for hay or grazing. Capability unit VIs–1. Jerauld soils in Thin Claypan range site and windbreak group 10. Demky soils in Clayey range site and windbreak group 4.

Lowry Series

The Lowry series consists of deep, well-drained, nearly level to strongly sloping, silty soils on uplands. These soils formed in loess.

In a representative profile the surface layer is dark grayish-brown silt loam about 8 inches thick. The subsoil, about 13 inches thick, is silt loam that is grayish brown in the upper part and light brownish gray in the lower part. It is slightly hard when dry and friable when moist. The lower part of the subsoil is calcareous. The underlying material is calcareous, light brownish-gray and light-gray silt loam.

Lowry soils are moderate to moderately low in content of organic matter and medium in fertility. Permeability is moderate, and runoff is slow to medium. Available water capacity is high.

Many areas are in native grass which is used for grazing. Corn, small grain, and alfalfa are the main crops in cultivated areas.

Representative profile of Lowry silt loam, 0 to 2 percent slopes, in native grass, 2,000 feet south and 975 feet east of the NW. corner of sec. 4, T. 113 N., R. 81 W.:

A11—0 to 3 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, platy structure parting to weak, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

A12—3 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, prismatic structure parting to weak, fine, subangular blocky structure; soft, very friable; neutral; clear, smooth boundary.

B2—8 to 16 inches, grayish-brown (2.5Y 5/2) silt loam, dark grayish brown (10YR 4/2) moist; weak, medium, prismatic structure parting to weak, medium and fine, subangular blocky structure; slightly hard, friable, slightly sticky; neutral; clear, smooth boundary.

B3—16 to 21 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse and medium, prismatic structure parting to weak, medium, subangular blocky structure; slightly hard, friable; calcareous; mildly alkaline; clear, smooth boundary.

C1ca—21 to 28 inches, light brownish-gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; weak, coarse, prismatic structure parting to weak, medium and coarse, subangular blocky structure; slightly hard, very friable; few, fine segregations of lime; calcareous; moderately alkaline; clear, smooth boundary.

C2—28 to 60 inches, light-gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; massive; soft, very friable; calcareous; moderately alkaline.

The A horizon ranges from 5 to 9 inches in thickness and from dark gray to grayish brown in color. The B2 horizon ranges from 5 to 10 inches in thickness and is dark grayish brown or grayish brown in hue of 10YR or 2.5Y. Segregations of lime in the B3 and C horizons are few to many, and they range from fine to coarse in size. The B3 and C horizons are silt loam or loam. In the C horizon the content of fine sand gradually increases with depth.

Lowry soils are near Agar and Sully soils or are mapped with them. They contain less clay in the B horizon than Agar soils. Lowry soils have colors of very dark grayish brown or darker when moist to a greater depth than Sully soils, and they are deeper to lime than Sully soils.

Lowry silt loam, 0 to 2 percent slopes (LoA).—This soil is on uplands near Lake Oahe. It has the profile described as representative for the series. Included in mapping were areas of Agar soils intermingled with this soil and of Onita soils in swales.

Tilth is good, and this soil is easy to work. It is relatively free of stones. Runoff is slow, and available water capacity is high. Control of soil blowing is the main concern in management. Also, management is needed to conserve moisture and to maintain tilth, content of organic matter, and fertility.

Many areas are cultivated. Corn, small grain, and alfalfa are the main crops. Other areas are in native grass used for grazing and hay. Capability unit IIe–1; Silty range site; windbreak group 3.

Lowry silt loam, 2 to 5 percent slopes (LoB).—This soil has long and smooth slopes and is on uplands near Lake Oahe. The profile of this soil is similar to that described as representative for the series, except the surface layer of this soil is about 5 inches thick.

Included with this soil in mapping were areas of Agar soils that are intermingled with Lowry soils and areas of Onita soils in swales.

Tilth is good; this soil is easy to work. It is relatively free of stones. Runoff is medium, and available water capacity is high. Controlling water erosion and soil blowing are the main concerns in management. Also, management is needed to conserve moisture and to maintain tilth, content of organic matter, and fertility.

Many areas are in native grass used for grazing and hay. Corn, small grain, and alfalfa are the main cultivated crops. Capability unit IIe–1; Silty range site; windbreak group 3.

Lowry silt loam, 5 to 9 percent slopes (loC).—This soil is on uplands near Lake Oahe. It has a profile similar to that described as representative for the series, but the surface layer is thinner.

Included with this soil in mapping were areas of Agar and Sully soils. Agar soils are in the lower parts of the landscape, and Sully soils are near or on the tops of ridges and knolls.

Tilth is good, and this soil is relatively free of stones. Runoff is medium. Gullies form easily. The main concern in management is the control of water erosion and soil blowing. Also important are conserving moisture and maintaining tilth, content of organic matter, and fertility.

Most areas are in native grass used for grazing and hay. In cultivated areas small grain and alfalfa are the main crops. Capability unit IIIe–1; Silty range site; windbreak group 3.

Lowry silt loam, 9 to 12 percent slopes (loD).—This soil is on upland ridges near Lake Oahe. It has a profile similar to the one described as representative for the series, except the surface layer and the subsoil are thinner, and the depth to lime is about 10 inches. Also, in places the underlying material is clay loam, clay or shale below a depth of 40 inches. Included with this soil in mapping were areas of Sully soils on some of the ridgetops.

Runoff is medium, and the soil is highly erodible. The main concern in management is controlling water erosion and soil blowing.

All areas are in native grass used for grazing. This soil is suited to cultivation if adequately protected against the hazard of erosion. Capability unit IVe–1; Silty range site; windbreak group 3.

Macken Series

The Macken series consists of deep, poorly drained, level, silty soils that have a clayey subsoil. These soils are in closed depressions on uplands. They formed in clayey alluvium washed in from adjacent soils.

In a representative profile the surface layer is gray silty clay loam about 2 inches thick. The subsoil, about 37 inches thick, is silty clay that is dark gray in the upper part and olive gray in the lower part. The upper part is very hard when dry, firm when moist, and sticky and plastic when wet. The lower part of the subsoil has strong-brown mottles and is calcareous. The underlying material is calcareous, light-gray, heavy silty clay loam.

Macken soils are moderate in content of organic matter and medium in fertility. Permeability is slow, and runoff water ponds on these soils. Available water capacity is moderate.

Most areas are in native grass used for hay or grazing. A few areas are cultivated, but crops grow poorly because of wetness.

Representative profile of Macken silty clay loam in native grass, 1,260 feet west and 245 feet south of the NE. corner of sec. 17, T. 113 N., R. 78 W.:

A1—0 to 2 inches, gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; weak, fine and medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; few fine and very fine iron-manganese concretions; neutral; clear, smooth boundary.

B21—2 to 8 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; weak, medium, prismatic structure parting to moderate, medium and fine, subangular blocky structure; hard, firm, sticky, plastic; few fine and very fine iron-manganese concretions; neutral; gradual, wavy boundary.

B22g—8 to 26 inches, dark-gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) moist; moderate, medium and coarse, prismatic structure parting to strong, medium and fine, blocky structure; very hard, firm, sticky, plastic; few fine and very fine iron-manganese concretions; mildly alkaline; gradual, smooth boundary.

B3gca—26 to 39 inches, olive-gray (5Y 5/2) silty clay, olive gray (5Y 4/2) moist; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, fine, subangular blocky structure; hard, firm, sticky, plastic; few fine segregations of lime; calcareous; moderately alkaline; clear, smooth boundary.

Cgca—39 to 60 inches, light-gray (5Y 7/2) heavy silty clay loam, light olive gray (5Y 6/2) moist; massive; slightly hard, very friable, slightly sticky, slightly plastic; common fine and medium segregations of lime; calcareous; strongly alkaline.

The A horizon ranges from 2 to 4 inches in thickness and is silty clay or silty clay loam. The B horizon is silty clay or clay. The C horizon is silty clay loam, silty clay, or clay. In places, buried A horizons are below a depth of 36 inches.

Macken soils, like Hoven soils, are in closed depressions. They lack the columnar structure in the B horizon of Hoven soils, and the B horizon of Macken soils has less sodium than that of Hoven soils.

Macken silty clay loam (0 to 1 percent slopes) (Ma).—This soil is in closed depressions on uplands. Areas are circular to oval in shape and commonly include intermittent lakes or ponds.

Included with this soil in mapping were areas of Hoven soils on the outer edges of the areas. In places Hoven soils make up as much as 20 percent of a mapped area.

This soil is ponded, and it is too wet for cultivation. Also, it has poor tilth and is difficult to work.

Most areas are in native grass used for hay or grazing. A few areas are cultivated, but crops seldom do well. Capability unit VIs–1; Closed Depression range site; windbreak group 10.

Oahe Series

The Oahe series consists of well-drained, nearly level to gently undulating, loamy soils that are moderately deep over gravel. These soils formed in loamy alluvium overlying glacial outwash and gravel on terraces and uplands.

In a representative profile the surface layer is dark-gray loam about 5 inches thick. The subsoil, about 10 inches thick, is dark grayish-brown heavy loam and light clay loam. It is slightly hard when dry and friable

to firm when moist. The underlying material is calcareous, light brownish-gray loam to a depth of 25 inches. Below that depth is calcareous, brown and pale-brown, stratified sand and gravel.

Oahe soils are moderate in content of organic matter and medium in fertility. Permeability is moderate in the subsoil and rapid in the underlying material. Runoff is slow to medium, and the available water capacity is low to moderate.

Many areas are in native grass used for grazing. Small grain, sorghum, and corn are the main cultivated crops.

Representative profile of Oahe loam, 0 to 2 percent slopes, 2,318 feet north and 168 feet west of the SE. corner of sec. 21, T. 113 N., R. 75 W.:

A1—0 to 5 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, very fine, subangular blocky structure and fine granular structure; soft, very friable; neutral; clear, smooth boundary.

B21—5 to 10 inches, dark grayish-brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to weak, fine, subangular blocky structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

B22—10 to 15 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, medium and fine, subangular blocky structure; slightly hard, firm, slightly sticky, slightly plastic; mildly alkaline; gradual, wavy boundary.

C1ca—15 to 25 inches, light brownish-gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; weak, coarse, prismatic structure; slightly hard, friable; common medium and fine segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

IIC2—25 to 60 inches, brown (10YR 5/3) and pale-brown (10YR 6/3) stratified sand and gravel, dark brown (10YR 4/3) moist; single grained; loose; calcareous; moderately alkaline.

Depth to lime commonly is about 14 inches, but it ranges from 11 to 20 inches. Depth to sand and gravel ranges from 20 to 40 inches. The A horizon ranges from 3 to 7 inches in thickness and from dark gray to gray in color. Texture commonly is loam but ranges from sandy loam to silt loam. The B2 horizon ranges from 7 to 14 inches in thickness.

Oahe soils are near or are mapped with Akaska, Ree, and Talmo soils. They are less silty than Akaska soils. Oahe soils differ from Ree soils in having sand and gravel at a depth of less than 40 inches and in having less clay in the B horizon. They are deeper over sand and gravel than Talmo soils.

Oahe loam, 0 to 2 percent slopes (OaA).—Most areas of this soil are on high terraces along North Medicine Knoll Creek. This soil has the profile described as representative for the series. The depth to gravel ranges from 22 to 40 inches.

Included with this soil in mapping were areas of Onita soils in swales and of Ree soils that are intermingled with Oahe soils.

This soil has good tilth and medium fertility. It has low to moderate available water capacity, however, and is somewhat droughty. Runoff is slow. Conservation of moisture is the main concern in management. This soil is suited to irrigation.

Many areas are in native grass used for grazing. In cultivated areas corn, sorghum, and small grain are the main crops. Early-maturing small grain and sorghum are better suited to this soil than corn and alfalfa. Capability unit IIIs–2; Silty range site; windbreak group 6.

Oahe loam, 2 to 6 percent slopes (OaB).—This soil is mostly on high terraces along Okobojo and North Medicine Knoll Creeks. It has a profile similar to the one described as representative for the series, but in places the surface layer is sandy loam.

Included with this soil in mapping were areas of Ree soils in places where the depth to gravel is more than 40 inches, and Talmo soils on the crests of some of the ridges.

Runoff is medium. Available water capacity is low to moderate, and the soil is somewhat droughty. The main concerns in management are the control of water erosion and soil blowing and the conservation of moisture.

Many areas are in native grass used for grazing. In cultivated areas corn, sorghum, and small grain are the main crops. Early-maturing small grain and sorghum are better suited to this soil than corn and alfalfa. Capability unit IIIe–6; Silty range site; windbreak group 6.

Oahe-Talmo loams, 0 to 2 percent slopes (OhA).—Oahe soils make up 60 to 80 percent of this complex, and Talmo soils, 20 to 40 percent. Most areas are on high terraces along North Medicine Knoll Creek. Oahe soils are in the flatter parts of the landscape. They have a profile similar to the one described as representative for their series, but in places the surface layer is sandy loam. Depth to gravel in the Oahe soil ranges from 20 to 30 inches. Talmo soils are on slight rises and undulations. They have a profile similar to the one described as representative for their series, but the surface layer is loam. Depth to gravel in the Talmo soil ranges from 6 to 12 inches.

Runoff is slow. These soils have low or very low available water capacity and are droughty. Also, Talmo soils are low in fertility. The main concern in management is conserving moisture.

Most areas are in native grass used for grazing or hay. Capability unit IIIs–2; Oahe soils in Silty range site and windbreak group 6; Talmo soils in Very Shallow range site and windbreak group 10.

Oahe-Talmo loams, 2 to 6 percent slopes (OhB).—The soils in this complex are gently undulating. Oahe soils make up 55 to 70 percent of this complex, and Talmo soils, 30 to 45 percent. Most areas are on high terraces along North Medicine Knoll Creek. Slopes are short and convex. Oahe soils are on side slopes. They have a profile similar to the one described as representative for their series, except that the surface layer is thinner and in places it is sandy loam. Depth to gravel is generally less than 28 inches. Talmo soils are on the tops of ridges and knolls. They have a profile similar to the one described as representative for the series, but the surface layer is loam.

Runoff is medium. Available water capacity is low or very low, and the soils are droughty. Controlling water erosion and soil blowing and conserving moisture are major concerns in management. Shallowness of the Talmo soils over gravel limits use on many areas to grazing.

Nearly all areas are in native grass used for grazing or hay. Only the Oahe parts are suited to cultivation. Capability unit VIs–4; Oahe soils in Silty range site and windbreak group 6; Talmo soils in Very Shallow range site and windbreak group 10.

Oko Series

The Oko series consists of deep, well-drained, nearly level to hilly, loamy soils that have a clayey subsoil. These soils formed in clayey glacial till on uplands.

In a representative profile the surface layer is dark grayish-brown clay loam about 3 inches thick. The subsoil, about 18 inches thick, is grayish-brown clay loam in the upper part, grayish-brown clay in the middle, and calcareous, light brownish-gray clay in the lower part. The middle part is very hard when dry and firm when moist. The underlying material is calcareous, light brownish-gray, gray, and light olive-gray clay. It contains chips and fragments of soft shale.

Oko soils are moderate in content of organic matter and medium in fertility. Permeability is moderately slow, and runoff is slow to rapid. Available water capacity is moderate to high.

Many areas are in native grass used for grazing and hay. In cultivated areas small grain, sorghum, and alfalfa are the main crops.

Representative profile of Oko clay loam in native grass in an area of Oko stony clay loam, 6 to 25 percent slopes, 260 feet south and 40 feet west of the NE. corner of sec. 21, T. 116 N., R. 76 W.:

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) clay loam, black (10YR 2/1) moist and very dark brown (10YR 2/2) crushed and moist; weak, fine, granular structure; hard, friable, slightly sticky, slightly plastic; mildly alkaline; clear, wavy boundary.

B21t—3 to 7 inches, grayish-brown (10YR 5/2) clay loam, very dark brown (10YR 2/2) moist and very dark grayish brown (2.5Y 3/2) crushed and moist; weak, medium, prismatic structure parting to moderate, fine, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; moderately alkaline; clear, wavy boundary.

B22tca—7 to 15 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; few very dark grayish-brown (10YR 3/2) moist organic stains on vertical faces of prisms; moderate, medium, prismatic structure parting to moderate, medium and fine, subangular blocky structure; very hard, firm, sticky, plastic; moderately thick patchy clay films; common coarse segregations of lime; calcareous; moderately alkaline; clear, wavy boundary.

B3ca—15 to 21 inches, light brownish-gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky structure; hard, firm, sticky, plastic; common medium and coarse segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—21 to 28 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) and dark grayish brown (2.5Y 4/2) moist; few, fine, yellowish-brown (10YR 5/4) and yellowish-red (5YR 5/8) mottles; weak, coarse, subangular blocky structure; hard, firm, sticky, plastic; few, fine, olive-gray shale chips; common medium segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2cs—28 to 33 inches, gray (5Y 6/1) and light olive-gray (5Y 6/2) clay, very dark gray (5Y 3/1) and olive gray (5Y 4/2) moist; weak, medium, subangular blocky structure; hard, firm, sticky, plastic; common olive-gray shale chips; many nests of gypsum crystals; calcareous; moderately alkaline; diffuse, wavy boundary.

C3—33 to 60 inches, gray (5Y 6/1) with bands of light olive-gray (5Y 6/2) clay, very dark gray (5Y 3/1) with bands of olive gray (5Y 4/2) moist; massive; hard, firm, sticky, plastic; many gray fragments of shale; calcareous; moderately alkaline.

The A horizon ranges from 2 to 4 inches in thickness and from dark gray to grayish brown in hue of 10YR or 2.5Y. It is clay loam or silty clay loam. The B21t horizon is clay loam, silty clay loam, or clay; and it ranges from 3 to 8 inches in thickness. In the C horizon mottles, nests of gypsum crystals, and fragments of shale range from few to many. In places bedded shale is between depths of 40 and 60 inches.

Oko soils are near Gettys, Peno, and Raber soils. They have horizons with colors of very dark grayish brown or darker when moist to a greater depth than those in Getty soils. Oko soils have a B horizon, but Getty soils do not. They have a more clayey Bt horizon than Peno and Raber soils.

Oko clay loam, 0 to 3 percent slopes (OkA).—This soil is on uplands in areas where the glacial till is clayey, and it contains fragments of shale. The profile of this soil is similar to that described as representative for the series, except that the surface layer is thicker and the depth to lime is about 11 inches.

Included with this soil in mapping were areas of Hurley, Peno, and Raber soils. Hurley soils are in low areas and along drainageways. Peno and Raber soils are on some of the rises.

Runoff is slow and permeability is moderately slow. If the soil is cultivated, tilth deteriorates. Available water capacity is moderate to high. The main concerns in management are conserving moisture and improving tilth. Also, management is needed to control soil blowing and to maintain content of organic matter and fertility.

Most areas are in native grass used for grazing and hay. Small grain and alfalfa are the main crops in cultivated areas. Capability unit IIIs–3; Clayey range site; windbreak group 4.

Oko clay loam, 3 to 6 percent slopes (OkB).—This soil is on uplands near Okobojo Creek and on some of the foot slopes around Artichoke and Sully Buttes. It has a profile similar to the one described as representative for the series, except that the surface layer is silty clay loam or silty clay in places. A few stones are scattered on the surface in some areas.

Included with this soil in mapping were areas of Peno soils on the higher parts of the landscape.

Runoff is medium, and permeability is moderately slow. The main concerns in management are controlling water erosion and soil blowing and improving tilth.

Almost all areas are in native grass used for grazing or hay. Capability unit IIIe–4; Clayey range site; windbreak group 4 .

Oko clay loam, 6 to 9 percent slopes (OkC).—This soil is on uplands near Okobojo Creek and Artichoke and Sully Buttes. Its profile is similar to the one described as representative for the series, except that in some areas the surface layer is silty clay loam or silty clay. A few stones are scattered on the surface in many areas, but generally not in amounts sufficient to hinder haying or tillage.

Included with this soil in mapping were areas of Peno soils in the upper parts of the landscape.

Runoff is medium, and permeability is moderately slow. The main concern in management is controlling erosion.

Almost all areas are in native grass used for grazing or hay. Capability unit IVe–4; Clayey range site; windbreak group 4.

Oko stony clay loam, 6 to 25 percent slopes (OlE).—This undulating to hilly soil is on the sides of the valley along Okobojo Creek and on the sides of buttes. Few to many stones and cobblestones are scattered on the surface in most areas. This soil has the profile described as representative for the series.

Included with this soil in mapping were areas of Gettys, Opal, and Peno soils. Gettys and Peno soils are in the higher parts of the landscape. Opal soils are in places where shale is at a depth of 20 to 40 inches.

Runoff is medium to rapid. Controlling erosion and stoniness are concerns in management.

Almost all areas are in native grass used for grazing. Stoniness and steep slopes limit the use of this soil to grazing. Capability unit VIIs–6; Clayey range site; windbreak group 10.

Onita Series

The Onita series consists of deep, moderately well drained to well drained, level to gently sloping, silty soils in swales and on foot slopes on uplands. These soils formed in alluvium washed in from adjacent soils.

In a representative profile the surface layer is dark-gray silt loam about 12 inches thick. The subsoil, about 26 inches thick, is dark grayish-brown silty clay loam in the upper part, dark grayish-brown silty clay in the middle, and calcareous, grayish-brown silty clay loam in the lower part. The middle part is hard when dry and firm when moist. The underlying material is calcareous, light yellowish-brown light silty clay loam.

Onita soils are high in content of organic matter and in fertility. Available water capacity is high, permeability is moderately slow, and runoff is slow to medium. Runoff from adjacent soils provides additional moisture in most areas.

Many areas are cultivated. Corn, small grain, and alfalfa are the main crops. Other areas are in native grass used for hay and grazing.

Representative profile of Onita silt loam, 0 to 2 percent slopes, in native grass, 1,647 feet south and 112 feet east of the NW. corner of sec. 13, T. 113 N., R. 77 W.:

A11—0 to 6 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; moderate, medium, granular structure; soft, very friable; neutral; gradual, smooth boundary.

A12—6 to 12 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak, medium, prismatic structure parting to weak, medium and coarse, subangular blocky structure; slightly hard, friable; neutral; clear, smooth boundary.

B21t—12 to 18 inches, dark grayish-brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) crushed and very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; thin continuous clay films on all faces of peds; neutral; gradual, smooth boundary.

B22t—18 to 30 inches, dark grayish-brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) crushed and very dark grayish brown (2.5Y 3/2) moist; weak, coarse, prismatic structure parting to strong, medium, blocky structure; hard, firm, sticky, plastic; thin continuous clay films on faces of peds; neutral; clear, smooth boundary.

B3—30 to 38 inches, grayish-brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) crushed and dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to moderate, medium, blocky structure; hard, firm, slightly sticky, slightly plastic; thin patchy clay films on faces of peds; calcareous; moderately alkaline; clear, smooth boundary.

Cca—38 to 60 inches, light yellowish-brown (2.5Y 6/3) light silty clay loam, light olive brown (2.5Y 5/3) moist; weak, medium, subangular blocky structure; slightly hard, friable; calcareous; moderately alkaline.

The A horizon ranges from 8 to 13 inches in thickness and is dark gray or very dark gray in color. The B2t horizon ranges from 12 to 27 inches in thickness and is dark grayish brown or grayish brown in hue of 10YR or 2.5Y. In places buried A horizons are at depths below 40 inches.

Onita soils are mapped with Agar, DeGrey, and Hoven soils and are near Glenham, Highmore, Raber, and Ree soils. They have a thicker A horizon than Agar, Glenham, Highmore, Raber, and Ree soils. In contrast to DeGrey and Hoven soils, the Bt horizon of Onita soils has no columnar structure and contains less sodium. Onita soils are better drained than Hoven soils.

Onita silt loam, 0 to 2 percent slopes (OnA).—This soil is in swales and along drainageways on uplands. Slopes are concave. This soil has the profile described as representative for the series.

Included with this soil in mapping were areas of DeGrey soils on the edges of small depressions and Hoven soils in the small depressions.

This soil is high in content of organic matter and in fertility. Available water capacity is high, permeability is moderately slow, and runoff is slow. Runoff from adjacent soils provides additional moisture. The main concern in management is conserving moisture.

Many areas are cultivated. Corn, small grain, and alfalfa are the main crops. Other areas are in native grass used for grazing and hay. Capability unit IIc–3; Overflow range site; windbreak group 1.

Onita silt loam, 2 to 5 percent slopes (OnB).—This soil is on foot slopes of valley sides where they merge into the bottom lands along Okobojo and North Medicine Knoll Creeks. This soil has a profile similar to the one described as representative for the series, except that the surface layer is thinner and the depth to lime is about 22 inches.

Included with this soil in mapping were areas of Ree soils in the higher parts of the landscape.

Runoff is medium. In most areas runoff from adjacent steeper soils provides additional moisture. Even though the extra moisture is beneficial to plants, this runoff contributes to the hazard of erosion. The main concern in management is controlling erosion.

Many areas are cultivated. Corn, small grain, and alfalfa are the main crops. Other areas are in native grass used for grazing and hay. Capability unit IIe–3; Silty range site; windbreak group 1.

Onita-DeGrey silt loams, 0 to 2 percent slopes (OrA).—Onita soils make up 50 to 75 percent of this complex; DeGrey soils, 20 to 45 percent; and other soils, about 5 percent. The areas consist of swales on uplands, and of outer edges of the valleys along Okobojo and North Medicine Knoll Creeks. The profile of the Onita soil is similar to the one described as representative for the Onita series, except that the surface layer is thinner and the depth to lime is about 25 inches. DeGrey soils are on the outer edges of the swales and valleys. Their profile is similar to the one described as representative for their series, except

that depth to lime is about 18 inches and in places the underlying material, to a depth of 60 inches or more, is silty clay loam.

Included with these soils in mapping were areas of Hoven soils in small depressions and Walke soils near the DeGrey soils.

Runoff is slow, and the runoff from adjacent soils provides additional moisture. The DeGrey soils have poor tilth and slow or very slow permeability. Their claypan subsoil releases moisture slowly to plants so that crop growth is uneven. The main concerns in management are conserving moisture and, in DeGrey soils, improving tilth and water intake.

About half the acreage is cultivated. Small grain, corn, and alfalfa are the main crops. Other areas are in native grass used for hay and grazing. Capability unit IIc–3; Onita soils in Overflow range site and windbreak group 1; DeGrey soils in Claypan range site and windbreak group 9.

Onita-Hoven silt loams, 0 to 1 percent slopes (OsA).—Onita soils make up 50 to 75 percent of this complex, and Hoven soils, 25 to 50 percent. This complex is in swales on uplands. The drainage pattern is ill defined, and in places the soil in small depressions is ponded. Hoven soils are in the depressions.

Included with this soil in mapping were areas of DeGrey and Walke soils on the edges of Hoven soils or in low areas that are less concave than the Hoven depressions.

The areas receive additional moisture because of runoff from adjacent soils. Although this runoff is generally beneficial to the Onita soils, it is detrimental to the Hoven soils which are ponded. Hoven soils have very slow permeability and are poor in tilth. Conserving moisture is one of the concerns in management. In cultivated areas management is needed to reduce wetness. In the Hoven soils it is needed to improve tilth and water intake.

Many areas are in native grass used for hay and grazing. In cultivated areas corn, small grain, and alfalfa are the main crops. Capability unit IIc–3; Onita soils in Overflow range site and windbreak group 1; Hoven soils in Closed Depression range site and windbreak group 10.

Opal Series

The Opal series consists of moderately deep, well-drained, gently sloping to steep, clayey soils on uplands. They formed in clayey materials weathered from the underlying soft shale.

In a representative profile the surface layer is gray and dark-gray clay about 6 inches thick. The subsoil, about 15 inches thick, is calcareous, grayish-brown clay. It is very hard when dry and firm when moist. The underlying material, to a depth of 32 inches, is calcareous, grayish-brown clay that contains nests of gypsum crystals and fragments of shale. Below a depth of 32 inches is gray and pale-olive shale.

Opal soils are moderate in content of organic matter and medium in fertility. Permeability is very slow to slow, although initial intake is rapid following dry periods when there are cracks in the soil. Runoff is medium to rapid. Available water capacity is low to very low.

Most areas are in native grass used for grazing. Small grain is the main crop in cultivated areas.

Representative profile of Opal clay, 2 to 6 percent slopes, in native grass, 2,573 feet south and 215 feet east of the NW. corner of sec. 12, T. 116 N., R. 79 W.:

A11—0 to 2 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; weak, medium and fine, subangular blocky structure parting to weak, fine, granular structure; hard, firm, sticky, plastic; neutral; clear, wavy boundary.

A12—2 to 6 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/2) moist and very dark grayish brown (10YR 3/2) crushed and moist; weak, medium and coarse, subangular blocky structure; very hard, very firm, sticky, plastic; mildly alkaline; gradual, wavy boundary.

B2—6 to 10 inches, grayish-brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) moist; weak, coarse, prismatic structure parting to moderate, coarse, blocky structure; extremely hard, very firm, sticky, plastic; calcareous; moderately alkaline; gradual, wavy boundary.

B3ca—10 to 21 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, medium, blocky structure; very hard, firm, sticky, plastic; few fine segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C1—21 to 32 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; very hard, firm, sticky, plastic; common fine fragments of olive (5Y 5/3) shale; common fine nests of gypsum crystals; calcareous; moderately alkaline; gradual, wavy boundary.

C2—32 to 60 inches, gray (5Y 5/1) and pale-olive (5Y 6/3) shale, very dark gray (5Y 3/1) and olive (5Y 4/3) moist; bedded; calcareous; moderately alkaline.

Depth to bedded shale ranges from 20 to 40 inches. The A horizon ranges from dark gray to grayish brown in hue of 10YR to 5Y. The A horizon is clay or silty clay and ranges from 4 to 8 inches in thickness. The B2 horizon is clay or silty clay and ranges from 4 to 12 inches in thickness.

Opal soils are near or are mapped with Dupree, Hurley, and Promise soils. They are deeper over shale than Dupree soils. Opal soils lack the columnar structure of the Hurley soils and contain less sodium. They are not so deep over shale as Promise soils.

Opal clay, 2 to 6 percent slopes (OtB).—This gently sloping soil is on uplands near Lake Oahe and in the vicinity of Sully Buttes. It has the profile described as representative for the series.

Included with this soil in mapping were areas of Hurley, Oko, and Promise soils. Hurley and Promise soils are on foot slopes. Oko soils are in places where deposits of clayey glacial till are over the underlying shale.

Tilth is poor. Permeability is very slow, and runoff is medium. Control of water erosion and soil blowing is the main concern in management. Also important are conserving moisture and maintaining or improving tilth, content of organic matter, and fertility.

Most areas are in native grass used for grazing or hay. Small grain is the main crop in cultivated areas. Capability unit IIIe–4; Clayey range site; windbreak group 4.

Opal clay, 6 to 9 percent slopes (OtC).—This soil is mainly in the vicinity of Artichoke and Sully Buttes. Its profile is similar to the one described as representative for the series, but the surface layer is thinner.

Included with this soil in mapping were areas of Oko and Promise soils. Oko soils occur in an erratic pattern in places where deposits of clayey glacial till are underlain by shale. Promise soils are on foot slopes.

Runoff is medium, and the soil is erodible. The main concerns in management are controlling water erosion

and soil blowing and conserving moisture. If this soil is cultivated, management is needed also to maintain or improve tilth, content of organic matter, and fertility.

Most areas are in native grass used for grazing or hay. Small grain is the main crop in cultivated areas. Capability unit IVe–4; Clayey range site; windbreak group 4.

Opal-Dupree clays, 6 to 21 percent slopes (OuD).—Opal soils make up 50 to 70 percent of this complex, and Dupree soils, 30 to 50 percent. Opal soils are in the middle and lower parts of the landscape. They have a profile similar to the one described as representative for the series, but the surface layer is thinner. Dupree soils are in the upper parts of the landscape and on the shoulders of drainageways. Their profile is similar to the one described as representative for the series, except that in places below gravelly ridges, the surface layer is gravelly clay or gravelly clay loam.

Included with these soils in mapping were areas of Oko soils. They are commonly on the ridgetops and have a few scattered stones on their surface.

Runoff is medium to rapid. The available water capacity is low to very low. The control of erosion and the conservation of moisture are the main concerns in management.

Nearly all of the acreage is in native grass used for grazing. In most areas the soils are too steep for cultivation, and the Dupree soils are not suited to cultivation because they are too shallow. Capability unit VIe–4 and windbreak group 10; Opal in Clayey range site; Dupree in Dense Clay range site.

Peno Series

The Peno series consists of deep, well-drained, gently undulating to undulating, loamy soils on uplands. These soils formed in glacial till.

In a representative profile the surface layer is dark-gray loam about 3 inches thick. The subsoil, about 16 inches thick, is dark-gray heavy clay loam in the upper part and calcareous, light brownish-gray heavy clay loam in the lower part. The subsoil is hard when dry and firm when moist. The underlying material is calcareous, light brownish-gray heavy clay loam.

Peno soils are moderate in content of organic matter and medium in fertility. Runoff is medium. Permeability is moderate in the subsoil and moderately slow in the underlying material. Available water capacity is moderate to high.

Many areas are in native grass used for grazing. Corn, sorghum, small grain, and alfalfa crops are grown in cultivated areas.

In Sully County Peno soils are mapped only with Raber soils.

Representative profile of Peno loam in an area of Raber-Peno loams, 3 to 6 percent slopes, 822 feet south and 48 feet west of the NE. corner of sec. 15, T. 116 N., R. 74 W.:

A1—0 to 3 inches, dark-gray (10YR 4/1) loam, dark grayish brown (10YR 4/2) crushed and very dark gray (10YR 3/1) moist; weak, medium, granular structure; soft; friable; neutral; clear, smooth boundary.

B2t—3 to 8 inches, dark-gray (10YR 4/1) heavy clay loam, very dark gray (10YR 3/1) moist and very dark grayish brown (10YR 3/2) crushed and moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; hard, firm, slightly sticky, slightly plastic; thin continuous clay films on all faces of peds; neutral; gradual, wavy boundary.

B3ca—8 to 19 inches, light brownish-gray (2.5Y 6/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky structure; hard, firm, slightly sticky, slightly plastic; few yellowish-red (5YR 5/8) iron stains; common medium and fine segrations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—19 to 42 inches, light brownish-gray (2.5Y 6/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; very weak, coarse, subangular blocky structure; hard, firm, slightly sticky, slightly plastic; few yellowish-red (5YR 5/8) iron stains; common fine segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2—42 to 60 inches, light brownish-gray (2.5Y 6/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, slightly sticky, slightly plastic; few yellowish-red (5YR 5/8) iron stains; few fine nests of gypsum crystals; few fine segregations of lime; calcareous; strongly alkaline.

Few to many stones and cobblestones are scattered on the surface, and few to common pebbles and cobblestones are throughout the profile. The A horizon ranges from 2 to 4 inches in thickness and from dark gray to grayish brown in color. The B2t horizon ranges from 4 to 7 inches in thickness. The B3ca and C1ca horizons have few to common segregations of lime. The C horizon is commonly heavy clay loam, but in places it is thinly stratified with layers of loamy or gravelly material. Mottles, stains, and nests of gypsum crystals are few to common in the lower part of the C horizon.

Peno soils are near Gettys and Raber soils or are mapped with them. Their dark colors extend to a greater depth than those of the Gettys soils, and they are deeper to lime. Peno soils have thinner A and B horizons than Raber soils.

Promise Series

The Promise series consists of deep, well-drained, nearly level to gently sloping, clayey soils on uplands and terraces. These soils formed in clayey materials weathered from clay shale, either in place or washed in from adjacent sloping soils.

In a representative profile the surface layer is about 5 inches thick. It is gray silty clay in the upper part and dark-gray clay in the lower part. The subsoil, about 20 inches thick, is calcareous, dark-gray and olive-gray clay. It is extremely hard when dry and very firm when moist. The underlying material is calcareous, olive-gray and pale-olive silty clay.

Promise soils are moderate in content of organic matter and medium in fertility. Runoff is slow to medium, and permeability is slow to very slow. Available water capacity is low to moderate. These soils crack when dry, and initial intake of water is rapid following dry periods.

Many areas are in native grass used for grazing and hay. Corn, small grain, and alfalfa are the main crops in cultivated areas.

Representative profile of Promise silty clay, 0 to 2 percent slopes, in native grass, 465 feet west and 110 feet north of the center of sec. 21, T. 114 N., R. 80 W.:

A11—0 to 2 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; weak, fine, subangular blocky structure parting to weak, fine, granular structure; hard, firm, sticky, plastic; neutral; clear, smooth boundary.

A12—2 to 5 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, medium, sub-

angular blocky structure parting to moderate, fine, granular structure; very hard, firm, sticky, plastic; mildly alkaline; gradual, wavy boundary.

B21—5 to 14 inches, dark-gray (5Y 4/1) clay, very dark gray (5Y 3/1) moist; moderate, medium, blocky and subangular blocky structure; extremely hard, very firm, sticky, plastic; calcareous; moderately alkaline; gradual, irregular boundary.

B22—14 to 25 inches, olive-gray (5Y 4/2) clay, dark olive gray (5Y 3/2) moist and olive gray (5Y 4/2) crushed and moist; moderate, medium, blocky and subangular blocky structure; extremely hard, very firm, sticky, plastic; calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—25 to 52 inches, olive-gray (5Y 5/2) silty clay, olive 5Y 4/3) moist; massive; very hard, firm, sticky, plastic; few fine nests of gypsum crystals; few fine segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C2—52 to 60 inches, pale-olive (5Y 6/3) silty clay, olive (5Y 5/3) moist; massive; very hard, firm, sticky, plastic; few fine nests of gypsum crystals; calcareous; moderately alkaline.

The A horizon ranges from 3 to 6 inches in thickness. It is silty clay or clay but in places the A11 horizon is silty clay loam. The B horizon ranges from dark gray to olive gray and grayish brown in hue of 5Y and 2.5Y. This horizon is clay or silty clay and ranges from 12 to 22 inches in thickness. Segregations of lime in the C1ca horizon range from few to common. The C horizon ranges from silty clay loam to silty clay or clay. In places bedded shale is between depths of 40 and 60 inches.

Promise soils are mapped near Hurley and Opal soils. They lack the columnar structure of Hurley soils and contain less sodium. Promise soils are deeper to shale than Opal soils.

Promise silty clay, 0 to 2 percent slopes (PrA).—Most areas of this soil are on uplands at the base of Artichoke and Sully Buttes. Slopes are long and smooth. This soil has the profile described as representative for the series. Included in mapping were areas of Hurley soils along some of the drainageways and places where the surface layer is silty clay loam.

This soil cracks as it dries, and it can absorb water rapidly for brief periods until the clay swells and the cracks close. Permeability is slow to very slow, and the clay layers release moisture slowly to plants. This soil loses its tilth easily if it is cultivated. Runoff is slow to medium. Conserving moisture, improving tilth, and controlling soil blowing are concerns in management.

Many areas are in native grass used for hay and grazing. Corn, small grain, and alfalfa are the principal crops in cultivated areas. Capability unit IIIs–3; Clayey range site; windbreak group 4.

Promise silty clay, 2 to 5 percent slopes (PrB).—This soil is mainly on uplands at the base of Artichoke and Sully Buttes. Slopes are long and smooth. The profile of this soil is similar to the one described as representative for the series, but in places the surface layer is silty clay loam.

Included with this soil in mapping were areas of Hurley and Oko soils. The Hurley soils are on foot slopes and along drainageways. The Oko soils are intermingled with this soil in some areas along Okobojo Creek.

This soil cracks and is extremely hard when dry. It is sticky and plastic when wet. Permeability is slow to very slow, and the clay layers release moisture slowly to plants. Runoff is medium. The main concerns in management are controlling water erosion and soil blowing, conserving moisture, and improving tilth.

Most areas are in native grass used for grazing and hay. Small grain, corn, and alfalfa are the main crops in cultivated areas. Capability unit IIIe–4; Clayey range site; windbreak group 4.

Raber Series

The Raber series consists of deep, well-drained, nearly level to undulating, loamy soils on uplands. These soils formed in clay loam glacial till.

In a representative profile the surface layer is dark-gray loam about 4 inches thick. The subsoil, about 34 inches thick, is clay loam that is dark grayish brown in the upper part and grayish brown in the lower part. It is hard to very hard when dry and firm to very firm when moist. The lower part of the subsoil is calcareous and has spots and streaks of segregated lime. The underlying material is calcareous, light brownish-gray heavy clay loam.

Raber soils are moderate in content of organic matter and medium in fertility. Permeability is moderately slow to slow and runoff is slow to medium. Available water capacity is moderate to high.

Many areas are cultivated. Corn, sorghum, small grain, and alfalfa are the main crops. Other areas are in native grass used for grazing and hay.

Representative profile of Raber loam in native grass in an area of Raber-Peno loams, 3 to 6 percent slopes, 2,215 feet south and 145 feet west of the NE. corner of sec. 8, T. 115 N., R. 74 W.:

A1—0 to 4 inches, dark-gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak, medium and fine, granular structure; soft, friable; neutral; clear, smooth boundary.

B21t—4 to 8 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, fine, prismatic structure parting to moderate, medium and fine, subangular blocky structure; hard, firm, slightly sticky, slightly plastic; thin patchy clay films on faces of peds; neutral; gradual, smooth boundary.

B22t—8 to 13 inches, dark grayish-brown (10YR 4/2) heavy clay loam, grayish brown (10YR 5/2) crushed and very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to strong, medium, blocky structure; very hard, very firm, slightly sticky, slightly plastic; thin continuous clay films on faces of peds; mildly alkaline; gradual, wavy boundary.

B3ca—13 to 38 inches, grayish-brown (2.5Y 5/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure parting to moderate, medium and coarse, blocky and subangular blocky structure; very hard, very firm, slightly sticky, slightly plastic; thin patchy clay films on faces of peds; few, fine, yellowish-red (5YR 5/8) iron stains; few, coarse, gray (5Y 5/1) fragments of shale; common to many medium and coarse segregations of lime; calcareous; moderately alkaline; gradual, wavy boundary.

C—38 to 60 inches, light brownish-gray (2.5Y 6/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, slightly sticky, slightly plastic; few, fine, yellowish-red (5YR 5/8) iron stains; few, coarse, gray (5Y 5/1) fragments of shale; few fine nests of gypsum crystals; calcareous; moderately alkaline.

Few to common pebbles and a few cobblestones are commonly on the surface and throughout the profile. The A horizon ranges from 3 to 6 inches in thickness and from dark gray to grayish brown in color. This horizon commonly is loam but it is silt loam or light silty clay loam in places. The B2t horizon is heavy clay loam or clay and ranges from 8 to 12 inches in thickness. In the C horizon iron stains, mottles, nests of gypsum crystals, and fragments of shale are few to common.

Raber soils are near Oko soils, and they are mapped with Cavo, Demky, Glenham, Highmore, and Peno soils. Raber soils lack the characteristic A2 or B&A horizon of Cavo and Demky soils, and they contain less sodium than those soils. They have a more clayey B horizon than Glenham and Highmore soils and are less clayey than Oko soils. Raber soils have a thicker B horizon and are deeper to lime than Peno soils.

Raber-Cavo loams, 0 to 2 percent slopes (RcA).—Raber soils make up 45 percent of this complex; Cavo soils, 40 percent; and other soils, 15 percent. The nearly level slopes are broken by very slight depressions and poorly defined drainageways. The profile of the Raber soil is similar to that described for its series, but the surface layer is thicker. The Cavo soils are in slight depressions or low areas. The Cavo soil that has the profile described as representative for the series is in this complex.

Included with these soils in mapping were areas of Demky and Walke soils in some of the low areas or in some of the slight depressions.

Runoff is slow. Available water capacity is moderate to high. Cavo soils have slow or very slow permeability, and the claypan subsoil releases moisture slowly to plants. Because of this, crops grow unevenly in areas of this complex. Cavo soils also have poor tilth if cultivated. The main concerns in management are conserving moisture and, in the Cavo soils, improving tilth.

About half of the acreage is cultivated. The rest is in native grass used for hay and grazing. Small grain, corn, and alfalfa are the main crops. Capability unit IVs–2. Raber soils in Clayey range site and windbreak group 3. Cavo soils in Claypan range site and windbreak group 9.

Raber-Cavo loams, 2 to 5 percent slopes ((RcB).—Raber soils make up 50 percent of this complex; Cavo soils, 35 percent; and other soils, 15 percent. Raber soils are in the middle and upper parts of the landscape. Cavo soils are on foot slopes and in swales. Included in mapping were Demky soils in the lower areas near Cavo soils.

Runoff is medium. Raber soils are well suited to cultivated crops, but the Cavo soils have slow or very slow permeability and poor tilth. Controlling water erosion and soil blowing on these soils and improving tilth and water intake of the Cavo soils are the main concerns in management.

Many areas are in native grass used for grazing and hay. Corn, small grain, and alfalfa are the main crops in cultivated areas. Capability unit IVs–3. Raber soils in Clayey range site and windbreak group 3. Cavo soils in Claypan range site and windbreak group 9.

Raber-Demky loams, 0 to 2 percent slopes (RdA).—Raber soils make up 50 to 65 percent of this complex; Demky soils, 30 to 45 percent; and other soils, about 5 percent. Raber soils are on slight rises. They have a profile similar to the one described as representative for their series, but the surface layer is thicker. The Demky soil is in the very slight depressions. It has the profile described as representative for the series. Included in mapping were Cavo and Walke soils in some of the low areas.

Runoff is slow. Available water capacity is moderate to high. Permeability is slow in Demky soil, which has a claypan subsoil that releases moisture slowly to plants. Tilth is usually poor in Demky soil. Conserving moisture and improving tilth and water intake in the Demky soil are the main concerns in management.

Many areas are cultivated. Corn, small grain, and alfalfa are the main crops. Other areas are in native grass used for grazing and hay. Capability unit IIc–2 and Clayey range site; Raber soils in windbreak group 3; Demky soils in windbreak group 4.

Raber-Demky loams, 2 to 5 percent slopes (RdB).—Raber soils make up 65 percent of this complex; Demky soils, 25 percent; and other soils, 10 percent. Raber soils have a profile similar to that described as representative for their series. Demky soils are in the lower parts of the landscape. They have a profile similar to that described as representative for their series, but in places the surface layer is silt loam.

Included with these soils in mapping were areas of Cavo soils in low areas and Glenham and Peno soils near the crests of rises.

Runoff is medium. Available water capacity is moderate to high. Controlling water erosion and soil blowing and conserving moisture are the main concerns in management. Demky soils also need management that will improve tilth and water intake.

Many areas are in native grass used for grazing and hay. In cultivated areas corn, small grain, and alfalfa are the main crops. Capability unit IIe–2 and Clayey range site; Raber soils in windbreak group 3; Demky soils in windbreak group 4.

Raber and Glenham loams, 3 to 6 percent slopes (RgB).—Some areas of these gently undulating soils are mainly Raber soils, and others are mainly Glenham soils. Still other areas consist of both soils in proportions that vary from one area to another. Slopes are short and irregular. A few stones are scattered on the surface in many of the areas. Profiles of both soils are similar to those described as representative for their respective series, except that in eroded spots the surface layer is thinner or has been mixed with the subsoil by plowing.

Included with these soils in mapping were areas of Eakin, Highmore, Hoven, and Onita soils. Eakin and Highmore soils are in parts of the landscape where slopes are smoother. Hoven soils are in small depressions, and Onita soils are in swales.

Tilth is good, and these soils are easily worked. Available water capacity is moderate to high. Runoff is medium. Controlling water erosion and soil blowing and conserving moisture are the main concerns in management.

Most areas are cultivated. Corn, small grain, and alfalfa are the main crops. Some areas are in native grass used for grazing and hay. Capability unit IIe–2 and windbreak group 3; Raber soils in Clayey range site; Glenham soils in Silty range site.

Raber and Glenham loams, 6 to 9 percent slopes (RgC).—Some areas of these undulating soils are mainly Raber soils, some are mainly Glenham soils, and others consist of both soils in proportions that vary from one area to another. Slopes are short and irregular. The sur-

face layer is thinner, but otherwise the Raber and Glenham soils have profiles similar to those described as representative for their respective series.

Included with these soils in mapping were areas of Eakin, Onita, and Peno soils. Eakin soils are on some of the side slopes, and Onita soils are in narrow swales. Peno soils are in the upper parts of some landscapes.

Runoff is medium. The main concern in management is controlling erosion. Also, management is needed in cultivated areas to control soil blowing, to conserve moisture, and to maintain content of organic matter and fertility.

Most areas are in native grass used for grazing or hay. In cultivated areas small grain, alfalfa, and tame grasses are the main crops. Capability unit IIIe–2 and windbreak group 3; Raber soils in Clayey range site; Glenham soils in Silty range site.

Raber-Highmore silt loams, 0 to 3 percent slopes (RhA).—Raber soils make up 50 to 65 percent of this complex; Highmore soils, 30 to 45 percent; and other soils, about 5 percent. Raber soils are on slight rises. They have a profile similar to the one described as representative for their series, except that the surface layer is silt loam and is thicker. Highmore soils are in slightly concave positions below Raber soils.

Included with these soils in mapping were areas of Eakin soils on some rises and Onita soils in swales.

Tilth is good, and these soils are easy to work. Available water capacity is moderate to high. Runoff is slow to medium. Conserving moisture and controlling soil blowing are the main concerns in management.

Most areas are cultivated. Corn, small grain, and alfalfa are the main crops. Capability unit IIc–2 and windbreak group 3; Raber soils in Clayey range site; Highmore soils in Silty range site.

Raber-Highmore silt loams, 5 to 9 percent slopes (RhC).—Raber soils make up 45 to 55 percent of this complex; Highmore soils, 25 to 35 percent; and other soils, about 20 percent. Raber soils are in the higher parts of the complex. They have a profile similar to that described as representative for their series, but the surface layer is silt loam. Highmore soils are in the lower and smoother parts of the landscape. They have a profile similar to the one described as representative for their series, except that the surface layer is thinner and the underlying material is clay loam between depths of 40 and 60 inches. Cultivated areas are slightly to moderately eroded.

Included with these soils in mapping were areas of Eakin, Onita, and Peno soils. Eakin soils are with Highmore soils in some areas. Onita soils are in narrow swales. Peno soils are on some of the ridgetops.

Tilth is good, and these soils are easy to work. Runoff is medium, and the soils are erodible. Controlling water erosion and soil blowing and conserving moisture are major concerns in management.

About half of the areas are cultivated. The rest is in native grass used for grazing and hay. Corn, small grain, and alfalfa are the main crops. Capability unit IIIe–2 and windbreak group 3; Raber soils in Clayey range site; Highmore soils in Silty range site.

Raber-Peno loams, 3 to 6 percent slopes (RpB).—These soils are gently undulating. Raber soils make up 50 to 60 percent of this complex; Peno soils, 30 to 40 percent; and other soils, about 10 percent. Slopes are short and irregular. Rabor soils are on side slopes. The soil that has the profile described as representative for the Raber series is in this complex. In places their surface layer is silt loam. Peno soils are on or near the tops of knolls. In areas of grassland they are marked by scattered stones on the surface. The soil that has the profile described as representative for the Peno series is in this complex.

Tilth is good, and available water capacity is moderate to high. Surface stones have been removed from most cultivated areas. Runoff is medium. Control of erosion is the main concern in management. Other management needs are conserving moisture and maintaining tilth, content of organic matter, and fertility.

Many areas are in native grass used for grazing and hay. Corn, sorghum, small grain, and alfalfa are the main crops in cultivated areas. Capability unit IIe–2; Clayey range site; windbreak group 3.

Raber-Peno loams, 6 to 9 percent slopes (RpC).—The soils in this complex are undulating. Raber and Peno soils each make up 40 to 50 percent of the complex, and other soils, as much as 10 percent. Slopes are short to medium in length and have an irregular shape. Raber soils are on side slopes. Peno soils are on the upper parts of the landscape near and on the tops of ridges and knolls. In areas of grassland, Peno soils have few to many stones on the surface.

Included with these soils in mapping were areas of Eakin and Gettys soils. In some areas Eakin soils are on side slopes with Raber soils. Gettys soils are on some of the ridges and knolls, intermingled with Peno soils.

The surface stones have been removed from most cultivated areas. Runoff is medium. Controlling erosion is the main concern in management.

Most areas are in native grass used for grazing and hay. Capability unit IIIe–2; Clayey range site; windbreak group 3.

Ree Series

The Ree series consists of deep, well-drained, level to gently sloping, loamy soils on terraces and uplands. These soils formed in loamy alluvium.

In a representative profile the surface layer is dark-gray loam about 6 inches thick. The subsoil, about 19 inches thick, is clay loam that is dark gray in the upper part, grayish brown in the middle, and light brownish gray in the lower part. The middle part is hard when dry and firm when moist. The lower part is calcareous. The underlying material is calcareous, light brownish-gray light clay loam and loam.

Ree soils are moderate in content of organic matter and medium in fertility. The available water capacity is high. Permeability is moderate, and runoff is slow to medium.

Many areas are cultivated. Corn, small grain, and alfalfa are the main crops. Other areas are in native grass used for grazing and hay.

Representative profile of Ree loam, 0 to 2 percent slopes, in cropland, 1,404 feet north and 420 feet east of the SW. corner of sec. 20, T. 113 N., R. 75 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) loam, dark grayish brown (10YR 4/2) crushed and very dark grayish brown (10YR 3/2) moist; moderate, medium, granu-

lar structure; soft, friable; neutral; abrupt, smooth boundary.

B21t—6 to 13 inches, dark-gray (10YR 4/1) clay loam, dark grayish brown (10YR 4/2) crushed and very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; thin patchy clay films on faces of peds; neutral; clear, smooth boundary.

B22t—13 to 18 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky structure; hard, firm, sticky, plastic; thin continuous clay films on faces of peds; mildly alkaline; clear, smooth boundary.

B3—18 to 25 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; calcareous; moderately alkaline; clear, smooth boundary.

C1ca—25 to 46 inches, light brownish-gray (2.5Y 6/2) light clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; common fine segregations of lime; calcareous; moderately alkaline; clear, smooth boundary.

C2—46 to 60 inches, light brownish-gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; massive; soft, friable; calcareous; moderately alkaline.

Depth to lime ranges from 14 to 24 inches. The A horizon ranges from 4 to 8 inches in thickness and from dark gray to grayish brown in color. Texture is loam or silt loam. In places the upper part of the B2t horizon is silty clay loam. The C horizon ranges from sandy loam to clay loam. Thin lenses of sand and fine gravel are below a depth of 40 inches in places.

Ree soils, like Akaska and Oahe soils, are on terraces. Unlike Akaska and Oahe soils, they lack sand and gravel at moderate depths. Ree soils are mapped with or are near Durrstein and Onita soils. They have less clay in the B horizon than those soils and are better drained. Ree soils have thinner A and B horizons than Onita soils.

Ree loam, 0 to 2 percent slopes (RrA).—This soil is on terraces along Okobojo and North Medicine Knoll Creeks. It has the profile described as representative for the series. In places the surface layer is silt loam.

Included with this soil in mapping were areas of Oahe soils on very slight rises and Onita soils in swales.

These soils have good tilth, moderate permeability, and high available water capacity. They are relatively free of stones. Runoff is slow. The conservation of moisture is the main concern in management.

Most of the acreage is cultivated, and a few areas are irrigated. Alfalfa, corn, and small grain are the main crops. Capability unit IIc–2; Silty range site; windbreak group 3.

Ree loam, 2 to 5 percent slopes (RrB).—This soil is on stream terraces. Slopes are long and smooth. The profile of this soil is similar to the one described as representative for the series, except that in places the underlying material is stratified with thin layers of fine sand or sandy loam at depths below 40 inches.

Tilth is good, and the soil is easy to work. Runoff is medium. Control of erosion is the main concern in management.

Many areas are in native grass used for grazing and hay. Alfalfa, corn, and small grain are the main crops in cultivated areas. Capability unit IIe–1; Silty range site; windbreak group 3.

Ree and Durrstein soils (0 to 1 percent slopes) (Rt).—Most areas of these soils are on low terraces and bottom lands along Okobojo and North Medicine Knoll Creeks. A few areas surround intermittent ponds and lakes on uplands. Some areas are mainly Ree soils, some are mainly Durrstein soils, and others are both Ree and Durrstein soils in proportions that vary from one area to another. Ree soils are on low terraces, and Durrstein soils are on bottom lands. These soils have profiles similar to the ones described as representative for their respective series, except that in places the surface layer of Ree soils is silt loam and that of Durrstein soils is silty clay loam.

Included with these soils in mapping were areas of Oahe and Onita soils. Oahe soils are on very slight rises. Onita soils are in very small, slight depressions within areas of Ree soils. In some areas these inclusions make up as much as 25 percent of the mapped areas.

The Ree soils are well suited to cultivation, but the Durrstein soils have a high water table and are high in content of salts. Conservation of moisture is the main concern in management of the Ree soils that are in areas large enough to cultivate. Wetness and salinity are concerns in these areas dominated by Durrstein soils.

Many areas are in native grass used for hay or grazing. Alfalfa is the main crop in cultivated areas. Ree soils in capability unit IIc–2; Silty range site; windbreak group 3. Durrstein soils in capability unit VIw–4; Saline Lowland range site; windbreak group 10.

Rough Broken Land

Rough broken land (15 to 50 percent slopes) (Ru) consists of the highest and steepest parts of the breaks along Lake Oahe. Areas are long and narrow. Few to many stones and boulders are on the surface. The underlying bedrock is clay shale; but the areas are commonly mantled with thin layers of wind-deposited silt, pockets of sand and gravel, and remnants of glacial till that ranges from gravelly loam to clay loam. Vertical banks and soil slips are common in areas of Rough broken land. No single soil or soil material dominates in these areas.

Included with Rough broken land in mapping were areas of Betts, Dupree, Gettys, and Sully soils, and outcrops of clay shale.

Runoff is rapid, and geologic erosion is active. The areas cannot be crossed by vehicle because of steep slopes, stoniness, and gullies. Controlling erosion is the main concern in management.

All areas are in native vegetation used for limited grazing. Composition and density of native grasses differs widely within the areas. Such shrubs as Rocky Mountain juniper and buckbrush are common in slump areas. Capability unit VIIs–6; not placed in a range site or a windbreak group.

Saline and Alkali Land

Saline and alkali land (0 to 3 percent slopes) (Sa) consists of mixed saline and alkali soils on foot slopes and fans. The mixed soils commonly have a gray surface layer ranging from loam to silty clay loam. Below this in many areas is massive clay that is high in salts. In places a thin claypan subsoil is below the surface. Included in some mapped areas are Durrstein and Egas soils.

This land type receives runoff water from adjacent, steep, clayey soils. This contributes to the high concentration of salts in and just below the surface layer. High salinity is the main concern in management of this land type.

All areas are in native grass used for grazing. Vegetation is sparse in many of the areas. Capability unit VIIs–5; Saline Lowland range site; windbreak group 10.

Shale Land

Shale land (6 to 40 percent slopes) (St) consists of areas dominated by exposures of clay shale adjacent to Lake Oahe. Included in mapping were areas of Dupree soils.

Runoff is very rapid, and geologic erosion is active. Controlling erosion and encouraging the growth of vegetation to help stabilize the areas are the main concerns in management.

Shale land is barren or almost completely lacking in vegetation. It has very little value as grazing land. Capability unit VIIIs–2; not placed in a range site or a windbreak group.

Sully Series

The Sully series consists of deep, well-drained, gently sloping to moderately steep, calcareous silty soils on uplands. These soils formed in loess.

In a representative profile the surface layer is light brownish-gray silt loam about 2 inches thick. The underlying material is pale-brown and light brownish-gray silt loam. It is soft to loose when dry and very friable when moist. A buried layer of grayish-brown silt loam is at a depth of 48 inches.

Sully soils are low in content of organic matter and in fertility. Permeability is moderate, and runoff is medium to rapid. Available water capacity is high.

All areas are in native grass used for grazing.

Representative profile of Sully silt loam, 12 to 25 percent slopes, in native grass, 2,245 feet west and 480 feet south of the NE. corner of sec. 9, T. 114 N., R. 81 W.:

A1—0 to 2 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak, very fine, granular structure; loose, very friable; calcareous; mildly alkaline; clear, smooth boundary.

C1—2 to 34 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak, very coarse, prismatic structure parting to weak, medium and coarse, subangular blocky structure; soft, very friable; calcareous; mildly alkaline; clear, wavy boundary.

C2—34 to 48 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; massive; loose, very friable; common very fine striations of segregated lime; calcareous; moderately alkaline; abrupt, smooth boundary.

Ab—48 to 60 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable; few very fine striations of segregated lime; moderately alkaline.

Texture of these soils is silt loam or very fine sandy loam with a slight increase of very fine sand as depth increases. The A horizon ranges from 2 to 5 inches in thickness and from dark grayish brown to light brownish gray. In places the A horizon is noncalcareous, and an AC horizon is present. Also, a IIC horizon of glacial till or clay shale is below a depth of 40 inches in places.

Sully soils, like Agar and Lowry soils, formed in loess. They have a thinner A horizon than those soils and are more calcareous. Sully soils are more silty than the nearby Betts and Gettys soils.

Sully silt loam, 12 to 25 percent slopes (SuE).—This soil is in areas near Lake Oahe. It has the profile described as representative for the series. In places clay shale or clay loam glacial till is at a depth of 40 to 60 inches.

Included with this soil in mapping were areas of Betts, Dupree, Gettys, and Lowry soils. Betts, Dupree, and Gettys soils are in places where silty material is absent. Lowry soils are in the lower parts of the landscape.

This soil is low in content of organic matter and in fertility. Runoff is rapid. Some areas are deeply gullied. Control of erosion is the main concern in management.

All areas are in native grass used for grazing. Capability unit VIe–3; Thin Upland range site; windbreak group 10.

Sully-Lowry silt loams, 3 to 12 percent slopes (SwD).—Sully soils make up 60 to 80 percent of this complex and Lowry soils 20 to 40 percent. Sully soils are in the upper and steeper parts of the areas and on ridgetops. Lowry soils are in the lower and smoother parts of the landscape. They have a profile similar to the one described as representative for the series, except that the surface layer is thinner and depth to lime is about 12 inches.

These soils are easy to work and have high available water capacity. The Sully soils are low in content of organic matter and low in fertility. Runoff is medium. Controlling erosion is the main concern in management.

All areas are in native grass used for grazing. The Lowry soils and areas of the more gently sloping Sully soils are suited to cultivation. Capability unit IVe–3. Sully soils in Thin Upland range site and windbreak group 10. Lowry soils in Silty range site and windbreak group 3.

Talmo Series

The Talmo series consists of excessively drained, nearly level to hilly, loamy soils that are very shallow over gravel. These soils formed in a thin layer of loamy material over gravel on uplands.

In a representative profile (fig. 10) the surface layer is dark-gray gravelly loam about 3 inches thick. Below this is a transitional layer of dark-gray gravelly loam about 5 inches thick. The material in these layers is soft when dry and very friable when moist. Brown gravel and sand are at a depth of 8 inches.

Talmo soils are moderately low in content of organic matter and low in fertility. Permeability is rapid, and runoff is medium. Available water capacity is low to very low.

All areas are in native grass used for grazing.

Representative profile of Talmo gravelly loam, 9 to 25 percent slopes, 2,162 feet east and 1,208 feet north of the SW. corner of sec. 7, T. 114 N., R. 74 W.:

A1—0 to 3 inches, dark-gray (10YR 4/1) gravelly loam, very dark gray (10YR 3/1) moist; weak, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

ACca—3 to 8 inches, dark-gray (10YR 4/1) gravelly loam, very dark grayish brown (10YR 3/2) moist; very weak, medium, prismatic structure; soft, very friable; few fine segregations of lime; moderately alkaline; gradual, irregular boundary.

Figure 10.—**Profile of Talmo gravelly loam, 9 to 25 percent slopes. Gravel and sand below a depth of 8 inches is poorly sorted.**

IIC—8 to 60 inches, varicolored, mostly brown (10YR 5/3) gravel and sand, dark brown (10YR 4/3) moist; single grained; loose; calcareous; moderately alkaline.

Depth to gravel and sand ranges from 3 to 12 inches. The A horizon ranges from 2 to 5 inches in thickness and from dark gray to grayish brown in color. Textures are gravelly loam, loam, sandy loam, and loamy sand. The AC horizon commonly ranges from 4 to 7 inches in thickness, but in some places an AC horizon is lacking. In places the IIC horizon is underlain by clay loam glacial till between depths of 40 and 60 inches.

Talmo soils are near Betts and Oahe soils. They contain more gravel and sand than Betts soils. They are more shallow over gravel and sand than Oahe soils.

Talmo gravelly loam, 9 to 25 percent slopes (TaE).—This rolling to hilly soil is on the sides of valleys along the larger drainageways and streams on uplands. Included in mapping were Betts soils in areas where sand and gravel are absent and Oahe soils in the mid and lower parts of the landscape. Inclusions make up as much as 25 percent of some mapped areas.

This soil has rapid permeability and low to very low available water capacity. The soil is too droughty for cultivation. Runoff is medium. Conserving moisture and controlling erosion are concerns in management.

All areas are in native grass used for grazing. Capability unit VIIs–4; Very Shallow range site; windbreak group 10.

Walke Series

The Walke series consists of deep, moderately well drained, nearly level, silty soils that have a compact, slowly permeable subsoil. These soils formed in silty material overlying clay loam glacial till on uplands.

In a representative profile the surface layer is dark-gray silt loam about 5 inches thick. Below this is a thin subsurface layer of gray silt loam about 2 inches thick. A transitional layer of gray silty clay loam, about 2 inches thick, is below the subsurface layer. The subsoil, about 17 inches thick, is dark grayish-brown heavy silty clay loam in the upper part and calcareous, light yellowish-brown silty clay loam in the lower part. It is hard when dry and firm when moist. The underlying material is calcareous, light brownish-gray and gray heavy clay loam.

Walke soils are moderate in content of organic matter and medium in fertility. Permeability and runoff are slow. Available water capacity is moderate to high.

Walke soils are about equally divided in cultivated areas and areas of native grass. Corn, small grain, and alfalfa are the main crops.

In Sully County Walke soils are mapped only with Agar and Highmore soils.

Representative profile of Walke silt loam in native grass in an area of Highmore-Walke silt loams, 0 to 2 percent slopes, 1,564 feet north and 542 feet west of the SE. corner of sec. 3, T. 113 N., R. 76 W.:

A1—0 to 5 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak, medium, granular structure; soft, very friable; neutral; clear, smooth boundary.

A2—5 to 7 inches, gray (10YR 5/1) silt loam, grayish brown (10YR 5/2) crushed and very dark gray (10YR 3/1) moist; thin, patchy, gray (10YR 6/1) coatings on faces of peds; weak, medium and fine, subangular blocky structure; soft, very friable; neutral; clear, smooth boundary.

B&A—7 to 9 inches, gray (10YR 5/1) silty clay loam (B part), grayish brown (10YR 5/2) crushed and very dark grayish brown (10YR 3/2) moist; gray (10YR 6/1) coatings of silt (A part) on vertical faces of peds; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; hard, firm, sticky, slightly plastic; thin patchy clay films on faces of peds; neutral; clear, smooth boundary.

B2t—9 to 15 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, grayish brown (10YR 5/2) crushed and very dark grayish brown (10YR 3/2) moist; moderate, coarse, prismatic structure parting to strong, medium, subangular blocky structure; hard, firm, sticky, plastic; thin continuous clay films on faces of peds; moderately alkaline; clear, smooth boundary.

B3ca—15 to 26 inches, light yellowish-brown (2.5Y 6/3) silty clay loam, olive brown (2.5Y 4/3) moist; weak,

coarse, prismatic structure parting to weak, medium, subangular blocky structure; hard, firm, slightly sticky, slightly plastic; few fine segregations of lime; calcareous; mildly alkaline; abrupt, smooth boundary.

IIC1ca—26 to 45 inches, light brownish-gray (2.5Y 6/2) heavy clay loam, grayish brown (2.5Y 5/2) moist; weak, coarse, subangular blocky structure; very hard, firm, sticky, plastic; common medium segregations of lime; calcareous; moderately alkaline; abrupt, smooth boundary.

IIC2cs—45 to 60 inches, gray (5Y 5/1) heavy clay loam, very dark gray (5Y 3/1) moist; massive; very hard, firm, sticky, plastic; many fine fragments of shale; common fine nests of gypsum crystals; calcareous; mildly alkaline.

The A1 horizon ranges from 4 to 7 inches in thickness and from dark gray to grayish brown in color. The A2 horizon is silt loam or silty clay loam and ranges from 1 to 3 inches in thickness. The B2t horizon is silty clay loam or silty clay and ranges from 5 to 10 inches in thickness. In places the lower part of the B3ca horizon is clay loam, and the C1ca horizon is a silty material instead of clay loam. The IIC2cs horizon has few to common nests of gypsum crystals and few to many fragments of shale.

Walke soils resemble DeGrey and Demky soils. They differ from DeGrey soils in having a B&A horizon and in having prismatic structure rather than columnar structure in the B2t horizon. They are more silty than Demky soils. Walke soils differ from the nearby Agar and Highmore soils in having an A2 horizon and a more clayey B horizon.

Use and Management of the Soils

This section discusses the use and management of the soils as cropland, for tame pasture, as range, for windbreaks, and for wildlife. A table showing predicted yields under two levels of management is provided. Also given is a discussion of engineering uses of soils, which contains information of value to engineers, planning commissions, town and country planners, and others.

General Management of Cropland [3]

About 48 percent of Sully County is cultivated. Corn, spring wheat, oats, and alfalfa are the main crops. Other important crops are winter wheat, sorghum, rye, and tame grasses. Row crops alternated with spring-sown small grain is the common croping system. Winter wheat is generally planted following a year of fallow. The long-range system commonly includes several years in alfalfa or tame grass.

The main concerns in managing cropland in Sully County are conserving moisture, controlling water erosion and soil blowing, and maintaining tilth, content of organic matter, and fertility.

Moisture can be conserved by reducing evaporation, by limiting surface runoff, by increasing intake of moisture, and by controlling weeds. Practices that help achieve these objectives are stubble mulching, returning crop residue to the soil, contour farming, contour stripcropping, planting field windbreaks, minimum tillage, chiseling, and subsoiling. Fallow preceding the planting of winter wheat helps to control weeds, as well as to store moisture.

Many of these practices help control erosion and soil blowing. Use of cover crops and grassed waterways also help reduce the risk of erosion. Wind stripcropping helps control soil blowing. Emergency tillage roughens the surface and reduces soil blowing until more lasting measures can be put into effect.

Use of green manure crops and animal manures, use of grasses and legumes in the cropping system, and managing crop residue help in maintaining tilth, content of organic matter, and fertility. Tillage pans form easily in many of the soils in Sully County. Avoiding tillage when the soil is wet and alternating depth of tillage helps to prevent the formation of tillage plans. Existing tillage pans can be broken by chiseling and subsoiling. Chiseling and subsoiling are also effective in increasing water intake in claypan soils such as Cavo and DeGrey. Timely tillage is also important in maintaining tilth in claypan soils and in clayey soils such as Promise silty clay.

Many of the cultivated soils in Sully County show evidence of a deficiency in nitrogen, particularly in years when rainfall is above average. Information about the use of chemical fertilizer can be obtained from the local office of the Soil Conservation Service and from the county agricultural extension agent.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive land-forming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management. A complete discussion of the capability system is given in "Land Capability Classification" (*2*).

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, the kinds of soils are grouped at three levels: the capability class, subclass, and unit. These levels are discussed in the following paragraphs.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use. (None in Sully County)

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

[3] By Walter N. Parmeter, conservation agronomist, Soil Conservation Service.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife. (None in Sully County)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation. There are no class I or class V soils in Sully County.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–3 or IIIe–6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitations; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

Management by capability units

In the following pages each of the capability units in Sully County is described, and suggestions for the use and management of the soils in each unit are given. The capability units with a capability subclass are not numbered consecutively because not all of the units in the statewide system are used in this county.

The names of the soil series represented are mentioned in the description of each unit, but this does not mean that all the soils in a given series are in the unit. Also, a soil that is part of a soil complex may be assigned to a different capability unit from the one it is assigned to if it is mapped alone. Ordinarily a complex of soils is treated as a whole in crop management. The capability classification of each soil in Sully County is given in the "Guide to Mapping Units" at the back of this survey, just ahead of the soil maps.

CAPABILITY UNIT IIe–1

This unit consists of deep, gently sloping, silty and loamy soils of the Agar, Eakin, Highmore, and Ree series and the nearly level to gently sloping, silty soils of the Lowry series. Except for the Ree soils, these soils have a silt loam surface layer and a subsoil of silty clay loam or silt loam. Ree soils have a loam surface layer and a subsoil of clay loam. Slopes in most areas are long and smooth. Some of the cultivated areas are slightly eroded.

These well-drained soils are relatively free of stones and have good tilth. They are medium in fertility and have moderate amounts of organic matter. Available water capacity is high, permeability is moderate, and runoff is medium. The control of water erosion and soil blowing are the main concerns in management. Also, management is needed to conserve moisture and to maintain tilth, content of organic matter, and fertility.

Corn, small grain, and alfalfa are the main crops. The soils are suited to all crops that are common to the county.

Stubble mulching and returning crop residue to the soil, together with use of grasses and legumes in the cropping system, are good management practices that help to keep soil losses at a minimum. Contour farming, contour stripcropping (fig. 11), and terraces also help to control erosion.

CAPABILITY UNIT IIe–2

This unit consists of deep, gently undulating, loamy soils of the Demky, Glenham, Peno, and Raber series. These soils have a loam surface layer and a clay loam subsoil. Slopes are short and irregular. Many of the cultivated areas are slightly eroded.

These soils have good tilth and are easy to work. A few stones are scattered on the surface in places. The soils are medium in fertility and moderate in content of organic matter. Available water capacity is moderate or high, permeability is moderate to slow, and runoff is medium. The control of water erosion and soil blowing are the main concerns in management. Also, management is needed to conserve moisture and to maintain tilth, content of organic matter, and fertility.

Corn, sorghum, small grain, and alfalfa are the main crops. The soils are well suited to all crops common to the county.

Stubble mulching and returning crop residue to the soil, together with use of grasses and legumes, are good management practices that help to control erosion. Contour farming, contour stripcropping, and terraces also help to control erosion and conserve moisture, but these practices are difficult to apply in most areas because of the short, irregular slopes.

CAPABILITY UNIT IIe–3

Only Onita silt loam, 2 to 5 percent slopes, is in this unit. This soil is high in content of organic matter and high in fertility. Available water capacity is high, per-

Figure 11.—**Contour stripcropping on Highmore-Eakin silt loams, 2 to 5 percent slopes.**

meability is moderately slow, and runoff is medium. The areas receive additional moisture in the form of runoff from adjacent sloping soils. Controlling erosion is the main concern in management.

Corn, small grain, and alfalfa are the main crops. All crops common to the area grow well on this soil.

Stubble mulching and returning crop residue to the soil, together with use of grasses and legumes in the cropping system, help to control erosion. Contour farming and terraces also help to control erosion and are desirable if row crops are grown. Grassed waterways help to prevent gullying.

CAPABILITY UNIT IIc-2

This unit consists of deep, mainly nearly level, silty and loamy soils of the Agar, Demky, Eakin, Glenham, Highmore, Onita, Raber, Ree, and Walke series. Slopes are long and smooth, except for very gentle undulations in some areas of Eakin, Glenham, and Raber soils.

Agar, Eakin, Glenham, Highmore, Raber, and Ree soils are well drained. They are medium to high in fertility and contain moderate amounts of organic matter. Available water capacity is high, permeability is moderate to slow, and runoff is slow. Conservation of moisture is the main concern in management. Also, management is needed to control soil blowing and to maintain tilth, content of organic matter, and fertility.

The Onita soils are mapped with the Agar soils and are managed the same as the soils that surround them. The Demky and Walke soils have a compact, slowly permeable subsoil. The Demky soils are mapped with the Raber soils, and the Walke soils are mapped with the Agar soils. They require management that helps to increase the intake of water.

Corn, small grain, and alfalfa are the main crops. The soils are well suited to all crops grown in the county. The Demky and Walke soils are better suited to small grain and sorghum than to corn.

Stubble mulching and returning crop residue to the soil, together with use of grasses and legumes in the cropping system, are good management practices. Wind stripcropping helps to control soil blowing (fig. 12).

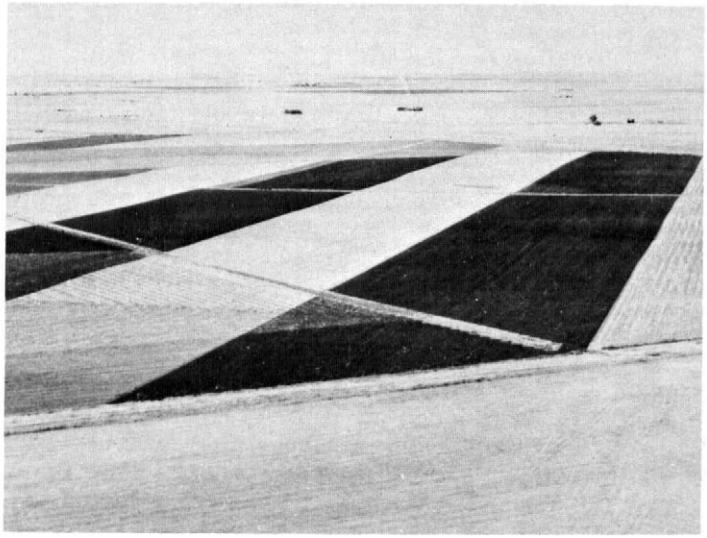


Figure 12.—**Wind stripcropping on Highmore-Eakin silt loams, 0 to 2 percent slopes.**

CAPABILITY UNIT IIc-3

In this unit are deep, mainly nearly level, silty soils of the DeGrey, Hoven, and Onita series. Onita soils have a surface layer of silt loam and a subsoil of silty clay loam and silty clay. DeGrey and Hoven soils have a claypan in

their subsoil, and Hoven soils are frequently ponded for short periods. In this unit the Hoven soils are mapped with the Onita soils and are not suited to cultivation. They are farmed as a matter of convenience because areas are small and occur erratically within the mapped areas.

Onita soils are high in content of organic matter and fertility. Available water capacity is high, permeability is moderately slow, and runoff is slow. The areas receive additional water from adjacent soils. This water generally benefits crops, but in wet years it may delay planting in spring and cause lodging of small grain in summer. Conservation of moisture is the main concern in management.

The DeGrey soils are mapped with the Onita soils and also require management that improves tilth and the intake of water.

Corn, small grain, and alfalfa are the main crops. Onita soils are well suited to all crops grown in the county.

Stubble mulching and returning crop residue to the soil are good management practices. Grassed waterways help to prevent gullying.

CAPABILITY UNIT IIIe-1

This unit consists of deep, sloping, silty soils of the Agar, Eakin, and Lowry series. These soils have a surface layer of silt loam and a subsoil of silty clay loam or silt loam. Slopes are long and smooth. Cultivated areas are slightly to moderately eroded.

These soils are relatively free of stones and have good tilth. They are medium in fertility and have moderate amounts of organic matter. Available water capacity is high, permeability is moderate, and runoff is medium. Controlling erosion is the main concern in management. Also, management is needed to control soil blowing, to conserve moisture, and to maintain tilth, content of organic matter, and fertility.

Corn, small grain, and alfalfa are the main crops. The soils are well suited to all crops grown in the county.

If use of row crops is limited, stubble mulching and returning crop residue to the soil, together with use of grasses and legumes in the cropping system and contour farming, are good management practices. If row crops are extensively used, contour stripcropping and terraces are generally needed to help control erosion. Grassed waterways help to prevent gullying.

CAPABILITY UNIT IIIe-2

This unit consists of deep, undulating, loamy and silty soils of the Glenham, Highmore, Peno, and Raber series. Slopes are irregular and are short to medium in length. Cultivated areas are slightly to moderately eroded.

These soils have good tilth, but commonly a few stones are scattered on the surface. Fertility is medium and content of organic matter is moderate. Available water capacity is moderate to high, permeability is moderate to moderately slow, and runoff is medium. The control of water erosion and soil blowing are the main concerns in management. Also, management is needed to conserve moisture and to maintain tilth, content of organic matter, and fertility.

These soils are well suited to all crops grown in the county. Row crops can be used in the cropping system if contour stripcropping and terraces are feasible, but in many areas slopes are too irregular to apply these mechanical practices. The alternative is to use close-growing crops, grasses, and legumes in the cropping system, together with stubble mulching and returning crop residue to the soil. Grassed waterways help to prevent gullying.

CAPABILITY UNIT IIIe-4

This unit consists of moderately deep and deep, gently sloping soils of the Oko, Opal, and Promise series. These soils have a surface layer of clay, silty clay, or clay loam and a subsoil of clay. Slopes are long. Cultivated areas are slightly to moderately eroded.

These soils lose their tilth easily when cultivated. Available water capacity is low to moderate, except for the Oko soils, where it is moderate to high. Permeability is moderately slow in Oko soils and slow to very slow in the Opal and Promise soils. Runoff is medium. The control of water erosion and soil blowing are the main concerns in management. Conserving moisture, maintaining fertility and content of organic matter, and improving tilth are other important management needs.

Small grain is the main crop. Corn and alfalfa are grown in areas of Promise soils. Many areas are in native grass.

Stubble mulching and returning crop residue to the soil, together with use of grasses and legumes in the cropping system, hold soil losses to an acceptable level. Contour farming, contour stripcropping, and terraces also help to control erosion. Grassed waterways help to prevent gullying.

CAPABILITY UNIT IIIe-6

This unit consists of gently sloping or gently undulating, loamy and silty soils of the Akaska and Oahe series. These soils are underlain with sand and gravel at a depth of 20 to 40 inches.

Akaska and Oahe soils have good tilth and are medium in fertility and moderate in content of organic matter. Permeability is moderate in the surface layer and subsoil and rapid in the underlying material. Available water capacity is low or moderate, and the soils are somewhat droughty. Controlling water erosion and soil blowing, conserving moisture, and maintaining tilth, content of organic matter, and fertility are the main concerns in management.

Corn, small grain, and alfalfa are the main crops. Small grain and sorghum are better suited to these soils than are corn and alfalfa.

Stubble-mulch tillage and returning crop residue to the soil are beneficial practices. If row crops are in the cropping system, contour stripcropping helps to control erosion and conserve moisture.

CAPABILITY UNIT IIIs-2

This unit consists of nearly level, loamy and silty soils of the Akaska, Oahe, and Talmo series. These soils are underlain by sand and gravel at a depth of 20 to 40 inches, except the Talmo soils, which have sand and gravel at a depth of 6 to 12 inches. In this unit the Talmo soils are mapped with the Oahe soils. They are not suited to cultivation.

Akaska and Oahe soils have good tilth. They are medium in fertility and moderate in content of organic matter.

Permeability is moderate in the surface layer and subsoil and rapid in the underlying material. Available water capacity is low or moderate, and the soils are somewhat droughty. Conserving moisture is the main concern in management. Also, management is needed to control soil blowing and to maintain tilth, content of organic matter, and fertility.

Corn, sorghum, small grain, and alfalfa are the main crops. Small grain and sorghum are better suited to these soils than are corn and alfalfa.

Stubble mulching, returning crop residue to the soil, and using grasses and legumes in the cropping system are good management practices.

CAPABILITY UNIT IIIs–3

This unit consists of deep, nearly level soils of the Oko and Promise series. These soils have a surface layer of clay loam or silty clay and a subsoil of clay. Slopes are long.

When cultivated, these soils lose their tilth. Runoff is slow. Permeability is moderately slow in the Oko soils and slow to very slow in the Promise soils. Improving tilth, conserving moisture, and controlling soil blowing are the main concerns in management.

Small grain is the main crop but some corn and alfalfa are grown on the Promise soils. Many areas are in native grass used for hay (fig. 13).

Figure 13.—**Promise silty clay, 0 to 2 percent slopes, used for hay.**

Stubble mulching, returning crop residue to the soil, and the use of grasses and legumes in the cropping system are good management practices. If row crops are in the cropping system, contour stripcropping is desirable on some of the longer slopes.

CAPABILITY UNIT IVe–1

Only Lowry silt loam, 9 to 12 percent slopes, is in this unit. Slopes are medium in length.

Tilth is good, and the soil is easy to work. Permeability is moderate, and available water capacity is high. Runoff is medium, and the soil is erodible. The control of water erosion and soil blowing are the main concerns in management.

All of the areas are in native grass used for grazing. If cultivated, use of close-sown crops and grasses and legumes in the cropping system, along with stubble mulching, help to control erosion. Terraces and contour stripcropping also help to control erosion.

CAPABILITY UNIT IVe–3

This unit consists of deep, gently undulating and gently sloping to strongly sloping, silty and loamy soils of the Glenham, Java, Lowry, and Sully series. These soils have a surface layer of silt loam or loam and a subsoil of silt loam or clay loam. Cultivated areas are slightly or moderately eroded. Slopes are short and irregular.

These soils have good tilth, but a few stones are scattered on the surface in some areas of the Java and Glenham soils. Fertility is medium or low, and content of organic matter is moderate or low. Permeability is moderate in the subsoil, and available water capacity is high. Runoff is medium, and the soils are easily eroded. Control of erosion, conservation of moisture, and improvement of fertility and content of organic matter are concerns in management.

Small grain, sorghum, alfalfa, and tame grasses are the main crops. Some corn is also grown.

Contour stripcropping or terraces help to control erosion, but in many of the areas, slopes are too irregular for these mechanical practices. The alternative is the use of close-sown crops, tame grasses, and legumes in the cropping system with little or no row crops. Stubble mulching, returning crop residue to the soil, green-manure crops, and application of animal manures are good management practices.

CAPABILITY UNIT IVe–4

This unit consists of deep and moderately deep, sloping soils of the Oko and Opal series. These soils have a surface layer of clay loam or clay and a subsoil of clay.

In cultivation the soils lose their tilth easily. Permeability is moderately slow in the Oko soils and very slow to slow in the Opal soils. Available water capacity is moderate to high in the Oko soils, but it is low to very low in the Opal soils. Runoff is medium. The control of water eroison and soil blowing, conservation of moisture, and improvement of tilth are all concerns in management.

Most areas are in native grass. Small grain is the main cultivated crop. Contour farming, contour stripcropping, and terraces help to control erosion in cultivated areas. Stubble mulching, returning crop residue to the soil, and use of grasses and legumes in the cropping system also are good management practices.

CAPABILITY UNIT IVw–1

Only Elpam silt loam is in this unit. It is a deep, level, silty soil that has a water table at depths ranging from 1½ to 3 feet.

This poorly drained soil is moist or wet during much of the growing season and is high in content of lime. Unless adequately drained, the soil is too wet for most crops except alfalfa and tame grasses. Most of the areas are in native grass.

CAPABILITY UNIT IVs–2

This unit consists of deep, nearly level, loamy and silty soils of the Agar, Cavo, DeGrey, Highmore, and Raber series. Cavo and DeGrey soils have a claypan subsoil.

Tilth is poor, and permeability is slow or very slow in the Cavo and DeGrey soils. They have moderate or high available water capacity, but the claypan subsoil releases water slowly to plants. Crops lack adequate moisture in midsummer. Improvement of tilth and increasing the intake of water into the claypan subsoil are the main concerns in management of Cavo and DeGrey soils.

Agar, Highmore, and Raber soils have moderate to slow permeability, and they do not have a claypan subsoil. Conservation of moisture is the main concern in management of these soils. Also important are the control of soil blowing and the maintenance of organic-matter content and fertility.

Corn, small grain, and alfalfa are the main crops. The Cavo and DeGrey soils are better suited to small grain, sorghum, and tame grasses than to corn or alfalfa.

Chiseling and the use of green-manure crops, animal manures, and grasses and legumes in the cropping system are among the practices that improve tilth and increase the intake of water. Stubble mulching and returning crop residue to the soil are management practices that help to conserve moisture and control soil blowing.

CAPABILITY UNIT IVs–3

This unit consists of deep, gently sloping, loamy soils of the Cavo and Raber series. Cavo soils have a claypan subsoil.

Runoff is medium, and the soils are susceptible to erosion. The Cavo soils have poor tilth, and their claypan subsoil releases moisture slowly to plants. The Raber soils have good tilth. Control of water erosion and soil blowing, together with improvement of tilth and the increase of water intake into the claypan subsoil of the Cavo soils, are the main concerns in management.

Many areas are in native grass. Corn, small grain, and alfalfa are the main crops. The Cavo soils are better suited to small grain, sorghum, and tame grasses than to corn.

Stubble mulching, returning crop residue to the soil, and contour farming or contour stripcropping help to control erosion and conserve moisture. Chiseling and the use of green-manure crops, animal manures, and grasses and legumes in the cropping system help to improve tilth and increase the intake of water into the subsoil.

CAPABILITY UNIT VIe–3

This unit consists of deep, undulating to moderately steep and hilly, loamy and silty soils of the Betts, Gettys, Java, and Sully series. These soils have a thin surface layer of loam or silt loam and are calcareous at or near the surface.

Fertility is medium or low, and the content of organic matter is moderate or low. Runoff is medium or rapid, and the soils erode easily if adequate vegetation is lacking. The control of erosion is the main concern in management.

These soils are too erodible for cultivation. Most areas are in native grass. Maintaining a good cover of vegetation helps to control erosion.

CAPABILITY UNIT VIe–4

Only Opal-Dupree clays, 6 to 21 percent slopes, is in this unit. Bedded shale is at a depth of 20 to 40 inches in the Opal soil and a depth of 6 to 20 inches in the Dupree soil.

These soils have very slow or slow permeability and low or very low available water capacity. Runoff is medium or rapid, and the soils are erodible. The control of erosion is the main concern in management.

These soils are too erodible for cultivation. Almost all areas are in native grass. Maintaining a good cover of vegetation helps to control erosion.

CAPABILITY UNIT VIw–1

Only Clayey alluvial land is in this unit. It consists of somewhat poorly drained, nearly level, mixed alluvial soils on narrow bottom lands.

These areas are flooded almost every year. The hazard of flooding and the small size and irregular shape of the areas make cultivation impractical.

This Clayey alluvial land is in native grass with a few native trees scattered throughout the narrow areas. All areas are well suited to grazing and to the development of wildlife habitat. Small areas are used for hay. Maintaining a good cover of vegetation lessens the risk of damage from flooding and streambank erosion.

CAPABILITY UNIT VIw–4

This unit consists of deep, poorly drained, silty soils of the Durrstein series. These soils have a claypan subsoil below a thin surface layer of silt loam. Salts are in the lower part of the subsoil and in the underlying material.

Tilth is poor, and permeability is slow to very slow. A water table is between depths of 3 and 8 feet. Wetness and the presence of salts in the subsoil are management concerns. Most of the areas of these soils are in native grass.

CAPABILITY UNIT VIs–1

This unit consists of deep, level to gently sloping soils of the Demky, Hoven, Hurley, Jerauld, and Macken series. Hoven, Hurley, and Jerauld soils have a claypan subsoil. They are in closed depressions and low areas on uplands. The Demky soils in this unit are suited to cultivation, but they are mapped with the Jerauld soils and occur as such small bodies it is not practical to cultivate them.

Drainage ranges from moderately well drained on the Hurley soils to poorly drained on the Hoven and Macken soils, where runoff is ponded. Permeability is slow or very slow. Tilth is poor, and the claypan subsoil restricts the cultivation of these soils. Most areas are in native grass used for grazing and hay.

CAPABILITY UNIT VIs–4

Only Oahe-Talmo loams, 2 to 6 percent slopes, is in this unit. These soils are underlain by sand and gravel at a depth of 20 to 40 inches in Oahe soils and at a depth of 3 to 12 inches in Talmo soils. The Oahe soils are suited to cultivation, but areas are not large enough to make cultivation practical. Talmo soils have low or very low available water capacity and are too droughty for cultivation. Maintaining a good vegetative cover helps meet the needs for conservation management.

CAPABILITY UNIT VIIs–2

This unit consists of sloping to steep, clayey soils of the Dupree and Opal series. Bedded clay shale is at depths ranging from 6 to 20 inches in the Dupree soils and 20 to 40 inches in the Opal soils. Most areas of these soils are moderately steep to steep.

Available water capacity is very low. Permeability is slow or very slow and surface runoff is medium or rapid. The soils are too shallow and too erodible for cultivation. All areas are in native grass. Maintaining a good vegetative cover helps meet the needs for conservation management.

CAPABILITY UNIT VIIs–4

This unit consists of rolling to hilly, loamy soils of the Talmo series. These gravelly loam soils are very shallow over gravel and sand.

Permeability is rapid, and the available water capacity is low to very low. The soil is too droughty for cultivation. It is subject to water erosion and soil blowing unless a good cover of vegetation is maintained.

CAPABILITY UNIT VIIs–5

This unit consists of saline and alkali soils of the Egas series and of the land type Saline and alkali land. Salts are at or near the surface (fig. 14).

These soils are too saline for cultivation. The native vegetation consists mainly of salt-tolerant grasses and forbs.

CAPABILITY UNIT VIIs–6

This unit consists of stony phases of the Betts, Java, and Oko series and the land type Rough broken land. These soils are gently undulating to steep. Stones and boulders commonly are scattered on the surface.

Some areas of the Java soils in this unit are suited to cultivation, but the areas are too small for practical cultivation. Java soils are mapped with the Betts soils.

The areas of this unit are too stony for cultivation or for use as hayland. Runoff is medium or rapid, and the areas are erodible unless a good cover of vegetation is maintained.

CAPABILITY UNIT VIIIs–2

This unit consists of areas of Shale outcrop mapped with Dupree soils and the land type, Shale land. Bedded clay shale is at or near the surface. Runoff is rapid on the steep slopes.

The areas are barren or nearly barren of vegetation and have little value as grazing land. Game animals occasionally browse on the few forbs growing in some of the areas.

Predicted Yields

Table 2 lists, for each soil in the county judged suitable for crops, the predicted average yields per acre of corn, oats, spring wheat, winter wheat, and alfalfa. The predictions are for dryfarmed soils under two levels of management.

The predicted yields in columns A are those that can be expected under management that is customarily practiced in the county. The two most commonly used cropping systems are winter wheat alternated with summer fallow; and row crops, primarily corn, alternated with

Figure 14.—Barren spots crusted with salts in area of Egas silty clay.

oats or spring wheat. Some legumes and tame grasses are used, but not in a regular sequence from field to field. Some practices are used to meet management objectives, but not sufficiently to meet all the management needs of a particular soil.

The predicted yields shown in columns B are those that can be expected under improved management, which includes (1) using a cropping system that helps maintain fertility and tilth; (2) use of crop residues together with green-manure crops and animal manures to help maintain organic matter; (3) using the practices needed to control erosion and soil blowing and to conserve moisture; (4) using clean, high-quality seed of adapted crop varieties; (5) planting, cultivating, and harvesting at the proper time; and (6) adding commercial fertilizer in amounts indicated by soil tests and field trials.

TABLE 2.—*Predicted average yields per harvested acre of principal dryfarmed crops*

[Yields in columns A can be expected under prevailing management; those in columns B can be expected under improved management. Only soils suitable for crops are listed. Dashed lines indicate the crop is not commonly grown on the soil or the soil is not suitable for cultivation. Soil complexes are given one yield based on the weighted averages of the composition of soils in the complex]

Mapping unit	Corn		Oats		Spring wheat		Winter wheat		Alfalfa	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Agar silt loam, 0 to 2 percent slopes	28	38	40	56	18	23	24	33	1.3	1.9
Agar silt loam, 2 to 5 percent slopes	26	36	34	50	16	20	22	30	1.1	1.8
Agar silt loam, 5 to 9 percent slopes	20	30	32	47	14	18	20	28	1.0	1.7
Agar-DeGrey silt loams, 0 to 2 percent slopes	20	29	31	43	14	20	20	28	1.0	1.7
Agar-Eakin silt loams, 0 to 2 percent slopes	27	37	37	51	17	22	23	32	1.3	1.9
Agar-Eakin silt loams, 2 to 5 percent slopes	25	34	32	48	16	20	22	30	1.1	1.8
Agar-Eakin silt loams, 5 to 9 percent slopes	19	29	30	45	12	16	18	26	.9	1.6
Agar-Onita silt loams, 0 to 1 percent slopes	31	41	42	57	19	25	25	35	1.4	2.1
Agar-Walke silt loams, 0 to 2 percent slopes	25	34	38	52	17	22	24	33	1.2	1.8
Akaska silt loam, 0 to 2 percent slopes	20	26	30	40	14	19	20	27	.9	1.4
Akaska silt loam, 2 to 5 percent slopes	17	24	26	36	12	17	19	25	.8	1.3
Elpam silt loam			20	30					1.3	1.8
Glenham loam, 0 to 3 percent slopes	24	34	36	50	17	22	22	31	1.2	1.7
Glenham loam, 3 to 6 percent slopes	22	32	33	46	16	20	20	27	1.0	1.6
Glenham loam, 6 to 9 percent slopes	19	28	30	42	14	18	18	26	.9	1.5
Highmore silt loam, 0 to 2 percent slopes	26	36	40	56	17	22	24	33	1.3	1.9
Highmore-DeGrey silt loams, 0 to 2 percent slopes	21	30	36	47	15	20	22	29	1.1	1.6
Highmore-Eakin silt loams, 0 to 2 percent slopes	26	36	37	51	17	22	24	33	1.2	1.8
Highmore-Eakin silt loams, 2 to 5 percent slopes	25	34	32	48	16	20	22	30	1.1	1.7
Highmore-Walke silt loams, 0 to 2 percent slopes	23	32	36	50	17	22	23	32	1.1	1.6
Java-Glenham loams, 3 to 9 percent slopes	16	24	27	37	12	17	16	24	.9	1.4
Lowry silt loam, 0 to 2 percent slopes	25	32	34	44	15	21	21	29	1.2	1.8
Lowry silt loam, 2 to 5 percent slopes	22	29	32	42	14	20	20	27	1.0	1.6
Lowry silt loam, 5 to 9 percent slopes	19	26	29	38	13	18	15	22	.9	1.5
Lowry silt loam, 9 to 12 percent slopes			25	34	12	17			.9	1.4
Oahe loam, 0 to 2 percent slopes	19	25	30	38	12	19	19	28	.9	1.4
Oahe loam, 2 to 6 percent slopes	16	24	26	34	11	17	17	23	.7	1.1
Oahe-Talmo loams, 0 to 2 percent slopes	10	15	20	25	8	11				
Oko clay loam, 0 to 3 percent slopes	17	22	31	42	14	18	20	28	1.0	1.5
Oko clay loam, 3 to 6 percent slopes	15	21	29	40	12	17	18	26	.9	1.4
Oko clay loam, 6 to 9 percent slopes	13	19	26	30	10	15	15	23	.8	1.2
Onita silt loam, 0 to 2 percent slopes	35	46	44	58	21	27	26	39	1.6	2.5
Onita silt loam, 2 to 5 percent slopes	30	42	38	52	17	24	24	34	1.3	2.0
Onita-DeGrey silt loams, 0 to 2 percent slopes	29	37	36	48	18	24	23	34	1.3	2.1
Onita-Hoven silt loams, 0 to 1 percent slopes	25	35	32	50	15	22	18	30	1.2	1.9
Opal clay, 2 to 6 percent slopes	17	22	25	37	13	18	20	28	.9	1.3
Opal clay, 6 to 9 percent slopes	14	19	20	30	12	16	18	24	.8	1.2
Promise silty clay, 0 to 2 percent slopes	19	24	35	45	14	20	24	31	1.1	1.5
Promise silty clay, 2 to 5 percent slopes	17	23	31	43	13	18	22	29	1.0	1.5
Raber-Cavo loams, 0 to 2 percent slopes	16	24	28	38	14	19	21	28	1.0	1.5
Raber-Cavo loams, 2 to 5 percent slopes	15	23	26	35	13	18	19	26	.9	1.3
Raber-Demky loams, 0 to 2 percent slopes	22	30	33	45	15	21	23	31	1.2	1.7
Raber-Demky loams, 2 to 5 percent slopes	21	29	32	42	15	20	21	28	1.0	1.5
Raber and Glenham loams, 3 to 6 percent slopes	22	30	33	44	16	21	21	29	1.0	1.5
Raber and Glenham loams, 6 to 9 percent slopes	19	28	30	41	15	20	18	26	.9	1.3
Raber-Highmore silt loams, 0 to 3 percent slopes	25	34	35	48	17	22	24	32	1.2	1.8
Raber-Highmore silt loams, 5 to 9 percent slopes	20	28	31	43	15	20	20	28	1.0	1.5
Raber-Peno loams, 3 to 6 percent slopes	20	27	30	40	15	19	19	26	1.0	1.4
Raber-Peno loams, 6 to 9 percent slopes	18	26	26	35	11	16	15	20	.8	1.2
Ree loam, 0 to 2 percent slopes	26	36	38	50	16	22	22	32	1.3	1.8
Ree loam, 2 to 5 percent slopes	24	33	36	48	15	20	21	30	1.1	1.6
Ree and Durrstein soils:										
Ree soil	26	36	38	50	16	22	22	32	1.3	1.8
Durrstein soil									.6	1.0
Sully-Lowry silt loams, 3 to 12 percent slopes									.8	1.3

The predicted yields are based on information supplied by farmers, by specialists of the Soil Conservation Service and the South Dakota Extension Service, and by others familiar with the soils of the county. These predictions were then compared and reconciled with the agricultural statistics of the South Dakota Crop and Livestock Reporting Service (*4*).

Management of Tame Pastures [4]

About 7 percent of Sully County is used as tame pasture. These pastures supplement the grazing provided by nearby native rangeland. Many of the tame pastures are grazed too closely during all or part of the grazing season. Close grazing reduces the production of forage and results in increased surface runoff. This exposes the soil to water erosion and soil blowing.

Grazing tame pastures in accordance with the amount of forage produced is basic to good pasture management. The largest return is obtained by withholding livestock from a pasture until a specific height of growth is reached, depending on the kinds of tame grasses in the pasture.

Other tame pasture practices that help to meet management objectives include rotation grazing, clipping to encourage uniform grazing, brush and weed control, use of fertilizers as needed, development of livestock water facilities, and reseeding to adapted grasses for stand improvement and increased production.

Sudangrass is used for temporary summer pasture, but perennial grasses are desirable for permanent pasture plantings. Bunch grasses such as crested wheatgrass and green needlegrass are not suited to planting on slopes in excess of 5 percent unless planted with sod-forming grasses.

In the following paragraphs, soils of Sully County are grouped into pasture suitability groups. Only those groups of the statewide system that are present in Sully County are described. Only those soils suited to tame pasture are placed in pasture groups. The names of the soil series represented are mentioned in the description of each group, but this does not mean that all the soils of a given series are in the group. To find the pasture group of a given soil, turn to the "Guide to Mapping Units."

PASTURE GROUP B

This group consists of deep, poorly drained, level soils of the Hoven and Macken series. These soils have a clayey subsoil and are in depressions on uplands. Runoff water ponds in the areas and remains from a few days in some years to as long as several weeks in wet years. The additional moisture generally is beneficial in wet years.

Creeping foxtail, reed canarygrass, and western wheatgrass are the principal species adapted to these soils. They can be planted alone or with each other.

PASTURE GROUP C

In this group are deep, moderately well drained, nearly level to gently sloping soils of the Cavo and DeGrey series. These soils have a loam or silt loam surface layer that crusts when dry and a dense, claypan subsoil. Runoff is slow to medium, and permeability is slow to very slow. Available water capacity is moderate to high, but plant roots penetrate the claypan with difficulty.

Suitable grasses and legumes for these soils are crested wheatgrass, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, western wheatgrass, and alfalfa.

PASTURE GROUP D

Nearly level to gently sloping soils of the Akaska and Oahe series are in this group. These silty and loamy soils are moderately deep over sand and gravel. Available water capacity is low to moderate, and the soils are somewhat droughty.

Suitable grasses and legumes for these soils are crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa.

PASTURE GROUP E

In this group are deep, moderately well drained, nearly level to gently sloping soils of the Demky and Walke series. These are loamy and silty soils that have a compact, slowly permeable subsoil. Runoff is slow to medium, and permeability is slow. Root systems develop slowly in the compact subsoils, and plants lack sufficient moisture late in summer.

Suitable grasses and legumes are green needlegrass, crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa.

PASTURE GROUP F

In this group are deep, well-drained, nearly level to strongly sloping, silty and loamy soils of the Agar, Eakin, Glenham, Highmore, Java, Lowry, Peno, Raber, and Ree series. Permeability is moderate to moderately slow, and available water capacity is moderate to high. Soil-moisture relationships are favorable for growth of pasture plants.

Suitable grasses and legumes for these soils are smooth bromegrass, green needlegrass, crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa.

PASTURE GROUP G

In this group are deep, well-drained to excessively drained, gently sloping to moderately steep, loamy and silty soils of the Betts, Gettys, and Sully series. These soils have a thin surface layer and are calcareous at or near the surface. Fertility and the content of organic matter are low. Available water capacity is moderate to high, but runoff is medium to rapid and plants lack adequate moisture. The steeper soils are highly erodible.

Suitable grasses and legumes are crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa. Alfalfa is suitable only where planted with sod-forming grasses.

PASTURE GROUP I

In this group are moderately deep and deep, well-drained, nearly level to sloping soils of the Oko, Opal, and Promise series. These soils have a loamy and clayey surface layer and a clayey subsoil. Permeability is moderately slow to very slow, but the soils crack when dry, and this aids initial water intake until the soil swells and the

[4] By WALTER N. PARMETER, conservation agronomist, Soil Conservation Service.

cracks close. Root development is restricted in the clayey subsoil.

Suitable grasses and legumes are crested wheatgrass, pubescent wheatgrass, intermediate wheatgrass, smooth bromegrass, and alfalfa.

PASTURE GROUP J

In this group are poorly drained soils of the Durrstein and Elpam series. These soils have a fluctuating water table and are moderately alkaline at or near the surface. Durrstein soils have moderate amounts of salt at shallow depths, and Elpam soils are high in content of lime.

Suitable grasses are tall wheatgrass and western wheatgrass.

PASTURE GROUP K

In this group are deep, moderately well drained, nearly level to gently sloping, silty soils of the Onita series. These soils receive additional moisture in the form of runoff water from adjacent soils. The available water capacity is high. The increased moisture supply is sufficient to produce as much as two times the normal yield of forage produced by the well-drained upland soils.

Suitable grasses and legumes are big bluestem, smooth bromegrass, indiangrass, intermediate wheatgrass, green needlegrass, western wheatgrass, switchgrass, and alfalfa.

Use of the Soils as Range [5]

Prior to settlement, most of Sully County was covered with mixed prairie vegetation. Except for scattered clumps of trees along the larger creeks and in protected ravines, together with trees along the Missouri River, the vegetation was almost all grass.

As the county was settled, much of the grassland was plowed and farmed. Generally, the better soils were selected for cultivation. Many of the soils presently remaining in cultivation are steep, shallow, stony, poorly drained, or for some other reason not well suited to cultivation.

At the present time, about 289,000 acres, or about 45 percent of the land area in the county, is in native grass. The Dupree soil association is entirely in rangeland. A high percentage of the areas of the Betts-Durrstein and the Oko soil associations are in native grass. Most of the soils in these areas are not well suited to cultivation because of erodible slopes, stoniness, or poor natural drainage. Because of irregular slopes and stoniness, the percentage in native grass also is higher than the county average in the Glenham-Hoven and Raber-Glenham soil associations. The percentage of the Agar-Onita and Highmore-Eakin soil associations that are in native grass is lower than the county average. In these soil associations, tracts of rangeland are smaller and are intermingled with cropland.

Many areas of rangeland in Sully County have been heavily grazed over a long period. Close grazing has caused changes in the plant cover, which makes it difficult to determine the productive potential of rangeland unless range-site and range-condition techniques are used.

[5] By THOMAS H. POZARNSKY, range conservationist, Soil Conservation Service.

Range sites and condition classes

A range site is a distinctive kind of rangeland that differs from other kinds of rangeland in its potential to produce native plants. A range site is the product of all environmental factors responsible for its development. In the absence of abnormal disturbance and physical site deterioration, it supports a plant community that differs from that of other sites in terms of kind or proportion of plant species or in total annual yield.

Range condition is the present state of vegetation of a range site in relation to the climax or original vegetation for that site. Range condition classes are an expression of the degree to which the present composition, expressed in percent, has departed from that of the climax vegetation for a range site.

Four range condition classes are recognized: excellent, good, fair, and poor. A range is in *excellent condition* if 76 to 100 percent of the present vegetation is that of climax vegetation for that site. It is in *good condition* if the percentage is 51 through 75; in *fair condition* if the percentage is 26 through 50; and in *poor condition* if the percentage is 25 or less.

The purpose of determining range condition is to provide a measure of changes that have taken place in the plant cover and thereby provide a basis for predicting the nature of plant community changes to be expected from management and treatment.

A range condition guide for each range site is used to help determine range condition of rangeland. Range plants on a specific site are classified according to their response to grazing as decreasers, increasers, and invaders.

Decreasers are species in the climax vegetation that decrease in relative abundance when the site is subjected to continuous close grazing. *Increasers* are plants in the climax vegetation that generally increase in relative abundance as a result of continuous close grazing. *Invaders* are not members of the climax vegetation for a site, but they invade areas where the climax vegetation is depleted.

Description of range sites

The soils of Sully County are grouped into 11 range sites which are described in the following paragraphs. In each description are given important soil characteristics, principal plants, and estimates of yields. When all of these range sites are in excellent condition, the kinds of grass that provide the major source of forage for cattle make up 70 to 90 percent of the total annual yield. The yield estimates are for the entire annual growth above ground, and are not for what would be removed by normal grazing or haying use.

The names of the soil series in each site are given, but this does not mean that all the soils in a given series are in that site. To find the range site in which a given soil is placed and the page on which it is described, refer to the "Guide to Mapping Units."

SUBIRRIGATED RANGE SITE

Elpam silt loam is the only soil in this range site. This poorly drained, level, calcareous, silty soil is in low areas and along sluggish drainageways. A water table is at a depth of 1½ to 4 feet, and the soil is moist or wet

throughout the growing season. The soil has abundant moisture for producing luxuriant stands of tall and mid grasses, and it is sufficiently aerated for such grasses as big bluestem.

When this range site is in excellent condition, the main grasses are big bluestem, switchgrass, prairie cordgrass, indiangrass, and western wheatgrass. When it is closely grazed, western wheatgrass, Kentucky bluegrass, and sedges increase and replace the taller grasses. With continued close grazing, foxtail barley, Kentucky bluegrass, sedges, rushes, and annuals become dominant.

When the site is in excellent condition, the total annual air-dry yield per acre ranges from 4,000 pounds in an unfavorable year to 5,000 pounds in a favorable year.

SALINE LOWLAND RANGE SITE

This site consists of deep, poorly drained, silty and clayey soils of the Durrstein and Egas series. Also included were mixed soils of the land type Saline and alkali land. These soils have a water table at a depth of 2 to 8 feet, and they have moderate to high accumulations of salt at shallow depths. The surface is uneven in the more nearly level areas, and runoff water ponds in low spots (fig. 15).

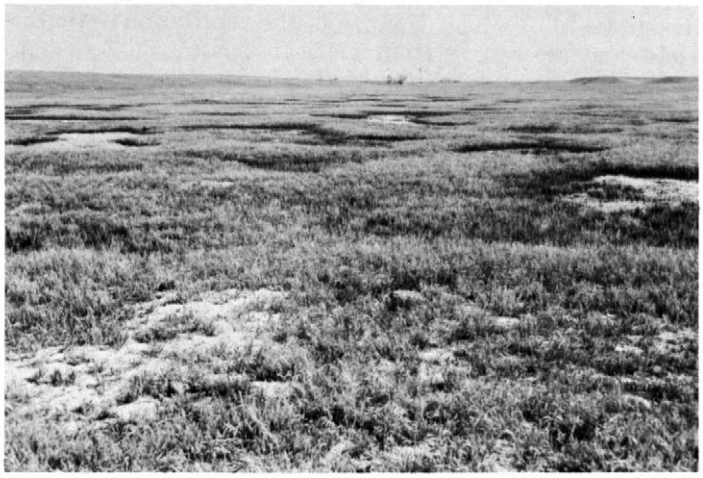


Figure 15.—**Saline Lowland range site in an area of Durrstein and Egas soils.**

Nuttall alkaligrass, alkali cordgrass, prairie cordgrass, switchgrass, and western wheatgrass are prominent when this range site is in excellent condition. Also present in lesser amounts are inland saltgrass, blue grama, buffalograss, sedges, and forbs. The last-named species, along with foxtail barley and annual weeds, increase as range condition declines.

When this site is in excellent condition, the total annual air-dry yield per acre ranges from 3,000 pounds in an unfavorable year to 4,500 pounds in a favorable year.

OVERFLOW RANGE SITE

In this site are deep, moderately well drained, silty soils of the Onita series and the somewhat poorly drained soils of the land type Clayey alluvial land. These soils receive additional moisture from the floodwaters of streams and drainageways, or in the form of runoff from adjacent soils. The additional moisture gives this site a potential to produce dense stands of tall and mid grasses.

When this site is in excellent condition, the main grasses are big bluestem, western wheatgrass, and green needlegrass. Small amounts of switchgrass, indiangrass, blue grama, and buffalograss are also present, and Kentucky bluegrass is present in places. If overgrazed, western wheatgrass increases and replaces the tall grasses. With continued overuse, blue grama, buffalograss, Kentucky bluegrass, and annual weeds and grasses become dominant.

When this site is in excellent condition, the total annual air-dry yield per acre ranges from 3,000 pounds in a dry year to 4,500 pounds in a favorable year.

CLOSED DEPRESSION RANGE SITE

This site consists of deep, poorly drained, level soils of the Hoven and Macken series. These soils have a surface layer of silt loam or silty clay loam and a subsoil of clay or silty clay. Runoff water is ponded, and permeability is slow or very slow.

When this site is in excellent condition, western wheatgrass and sedges are the main plants. Small amounts of blue grama and buffalograss are in some areas, and they increase as range condition declines. Foxtail barley, smartweed, and annual weeds become dominant where range condition is poor. Grazing these soils when they are wet encourages the increase of less desirable vegetation.

When this site is in excellent condition, the total annual air-dry yield per acre ranges from 3,000 pounds in an unfavorable year to 4,000 pounds in a favorable year.

SILTY RANGE SITE

In this site are well drained and moderately well drained, nearly level to rolling, silty and loamy soils of the Agar, Akaska, Eakin, Glenham, Highmore, Java, Lowry, Oahe, Onita, and Ree series. Except for Akaska and Oahe soils, these soils are deep and have moderate to high available water capacity. Akaska and Oahe soils are moderately deep over sand and gravel and have low to moderate available water capacity. Permeability is moderate except for Onita soils, which have moderately slow permeability.

When this site is in excellent condition, the main grasses are western wheatgrass, green needlegrass, needle-and-thread, and blue grama with lesser amounts of big bluestem, little bluestem, and side-oats grama. With overuse, western wheatgrass and needle-and-thread increase and replace the bluestems and green needlegrass. With continued overuse, these mid grasses are replaced by blue grama, fringed sagewort, and annual grasses and weeds.

When this site is in excellent condition, the total annual air-dry yield per acre ranges from 2,400 pounds in a dry year to 3,200 pounds in a favorable year.

CLAYEY RANGE SITE

This site consists of deep and moderately deep, well drained and moderately well drained, nearly level to steep soils that have a clayey subsoil. The surface layer ranges from loam to clay. These soils are of the Demky, Oko, Opal, Peno, Promise, Raber, and Walke series. Permeability ranges from moderately slow to very slow.

Available water capacity is moderate to high, except for Opal and Promise soils, where it is very low to moderate. The clayey subsoil somewhat restricts the development of plant roots.

When this site is in excellent condition, the main grasses are western wheatgrass and green needlegrass with small amounts of blue grama and buffalograss. Also present are lesser amounts of little bluestem, side-oats grama, and dryland sedges.

With overgrazing, western wheatgrass increases and replaces green needlegrass. With continued overgrazing, short grasses replace western wheatgrass. Curlcup gumweed, annual grasses, and weeds generally are prominent in areas that are in low range condition.

When this site is in excellent condition, the total annual air-dry yield per acre ranges from 2,200 pounds in a dry year to 2,900 pounds in a favorable year.

THIN UPLAND RANGE SITE

This site consists of deep, well-drained to excessively drained, gently sloping to steep, loamy and silty soils of the Betts, Gettys, and Sully series. These soils have a thin surface layer and are calcareous at or near the surface. Permeability is moderate, and available water capacity is moderate to high but runoff is medium to rapid.

When the site is in excellent condition, the main grasses are western wheatgrass, little bluestem, side-oats grama, green needlegrass, and needle-and-thread. Small amounts of blue grama and dryland sedges are also present.

With overuse, western wheatgrass and needle-and-thread increase and replace the other mid grasses. With continued overuse, blue grama, sand dropseed, dryland sedges, and annual grasses and weeds become dominant.

When this site is in excellent condition, the total annual air-dry yield per acre ranges from 2,000 pounds in a dry year to 2,700 pounds per acre in a favorable year.

CLAYPAN RANGE SITE

This site consists of deep, moderately well drained, nearly level to gently sloping, claypan soils of the Cavo and DeGrey series. These soils have a surface layer of loam or silt loam about 6 inches thick and a claypan subsoil that is very hard when dry. Permeability is slow to very slow. Available water capacity is moderate to high, but the claypan subsoil releases moisture slowly to plants.

When the site is in excellent condition, the main grasses are western wheatgrass, green needlegrass, and blue grama. With overgrazing, blue grama and buffalograss become dominant.

When this site is in excellent condition, the total annual air-dry yield per acre ranges from 1,600 pounds in a dry year to 2,400 pounds in a favorable year.

DENSE CLAY RANGE SITE

This site consists of shallow, well-drained, sloping to steep, clayey soils of the Dupree series (fig. 16). Bedded shale is at a depth of 6 to 20 inches. This soil has a subsoil of dense clay that restricts the development of plant roots. Permeability is slow, and available water capacity is very low.

When this site is in excellent condition, the grasses are almost entirely western wheatgrass and green needlegrass with no understory of short grasses. With overuse, green needlegrass is the first to disappear. With continued overuse, western wheatgrass thins out and is replaced by pricklypear, forbs, and annual grasses and weeds. In dry years areas in poor condition are nearly bare.

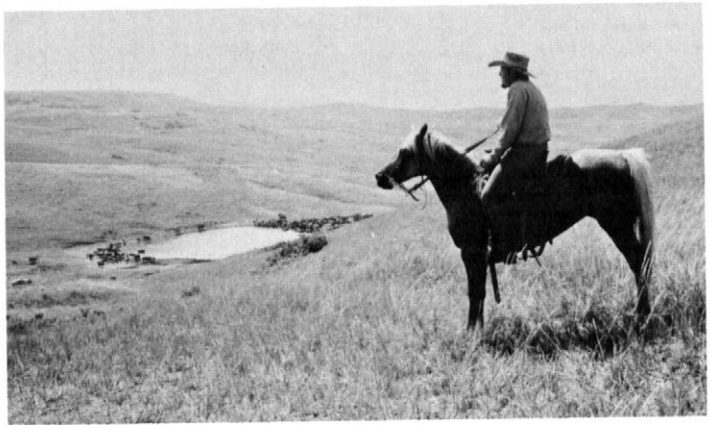


Figure 16.—**Dense Clay range site in an area of Dupree-Opal clays, 6 to 34 percent slopes.**

Forage production fluctuates widely on this site. When the site is in excellent condition, the total annual air-dry yield per acre ranges from 1,500 pounds in a dry year to 2,500 pounds in a favorable year.

THIN CLAYPAN RANGE SITE

This site consists of deep, moderately well drained to somewhat poorly drained, level to gently sloping claypan soils of the Hurley and Jerauld series. These soils have a thin surface layer of loam or silt loam about 3 inches thick. The claypan subsoil is very hard to extremely hard when dry, and roots penetrate it with difficulty. Salts are in the lower part of the subsoil or underlying material at a depth of less than 20 inches. Permeability is slow to very slow.

When this site is in excellent condition, the main grasses are western wheatgrass and blue grama. With overuse, blue grama and buffalograss become dominant. With continued overuse, inland saltgrass and pricklypear become prominent with much bare ground in dry years and with weeds in wet years.

When this site is in excellent condition, the total air-dry yield per acre ranges from 1,000 pounds in a dry year to 1,600 pounds in a favorable year.

VERY SHALLOW RANGE SITE

This site consists of excessively drained, nearly level to hilly loamy soils of the Talmo series. Depth to gravel and sand ranges from 3 to 12 inches. Permeability is rapid and available water capacity is low to very low.

When this site is in excellent condition, the main grasses are needle-and-thread, blue grama, hairy grama, and threadleaf sedge. Forbs and shrubs usually are in the plant community. With overuse, blue grama and threadleaf sedge become dominant along with forbs and weeds.

When this site is in excellent condition, the total annual air-dry yield per acre ranges from 1,000 pounds in a dry year to 1,600 pounds in a favorable year.

Use of the Soils for Windbreaks [6]

Much of the native woodland in Sully County has been inundated by Lake Oahe. Scattered native trees and shrubs are along the main creeks and drainageways, and they provide a limited amount of cover for wildlife.

Tree windbreaks have been planted in Sully County since the early days of settlement. The main purpose for planting trees is to establish windbreaks for the protection of fields, farmsteads (fig. 17), and winter feeding areas for livestock. Windbreaks also provide protection and cover for wildlife. Many of the existing windbreaks need supplementary plantings to make them more effective in keeping yards free of snow, in protecting livestock and buildings, in controlling soil blowing, and in conserving moisture.

Farmstead and feedlot windbreaks generally need a minimum of eight rows of trees and shrubs in order to provide adequate protection. The inside row should be far enough from the area to be protected so that snow does not accumulate where not wanted.

The purpose of field windbreaks is to help control soil blowing, conserve moisture, and lessen crop injury by hot summer winds. They can be one-row or multi-row plantings. Multi-row plantings generally do not need to exceed 5 rows in order to be effective.

On sloping soils, contour planting of windbreaks helps to control erosion and conserve moisture needed for the growth of trees.

[6] By ELMER L. WORTHINGTON, woodland conservationist, Soil Conservation Service.

To assist in planning and establishing windbreaks, the soils of Sully County are placed in windbreak suitability groups. These groups identify special management and site performances and also indicate the suitability of various species of trees and shrubs.

Table 3 can be used as a guide in planning windbreaks. It lists the species best suited for each windbreak suitability group. Tree heights listed are based on measurements and observations made on windbreaks that are at least 20 years old and that have been given adequate care. The criteria for the condition classes are as follows:

Good. One or more of the following are present. Leaves or needles are normal in color and growth; small amounts of dead wood (tops, branches, and twigs) may occur within the live crowns; evidence of disease, insect, and climatic damage is limited; there may be slight evidence of suppression or stagnation.

Fair. One or more of the following are present. Leaves or needles are obviously abnormal in color and growth; substantial amounts of dead wood (tops, branches, and twigs) are within the live crowns; evidence of disease, insect, or climatic damage is obvious; definite suppression or stagnation exists; current year's growth is obviously less than normal.

Poor. One or more of the following are present. Leaves or needles are very abnormal in color and growth; very large amounts of dead wood (tops, branches, and twigs) are within the live crowns; evidence of extensive disease, insect or climatic damage are obvious; plants show the effect of severe stagnation, suppression, or decadence; current year's growth is negligible.

Figure 17.—Farmstead windbreak on Highmore-Eakin silt loams, 0 to 2 percent slopes, 2 years after planting.

TABLE 3.—*Estimated condition and height of trees and shrubs in windbreaks at 20 years of age*

[No height range is given for a condition of poor. Soils in windbreak group 10 are not suited to windbreak plantings]

Species	Windbreak group 1		Windbreak group 3		Windbreak group 4		Windbreak group 6		Windbreak group 9	
	Condition	Height	Condition	Height	Condition	Height	Condition	Height	Condition	Height
Trees:		*Ft.*		*Ft.*		*Ft.*		*Ft.*		*Ft.*
Black Hills spruce	Good	20–30	Good	20–28	Poor		Poor		Poor	
Blue spruce	Good	20–30	Good	20–28	Poor		Poor		Poor	
Boxelder	Fair	20–30	Fair	20–28	Poor		Poor		Poor	
Chinkota elm	Good	30–40	Good	30–32	Good	36–40	Fair	17–22	Fair	10–14
Eastern redcedar	Good	15–20	Good	9–15	Good	10–17	Fair	9–12	Fair	5–8
Golden willow	Good	30–40	Poor		Poor		Poor		Poor	
Green ash	Good	20–30	Good	20–28	Good	17–26	Fair	12–15	Fair	10–14
Hackberry	Good	20–30	Good	20–28	Good	17–26	Fair	9–12	Poor	
Honeylocust	Good	30–40	Good	30–32	Good	30–32	Fair	17–22	Poor	
Plains cottonwood	Fair	32–36	Poor		Poor		Poor		Poor	
Ponderosa pine	Good	20–30	Good	20–28	Poor		Fair	12–15	Fair	10–14
Siberian crabapple	Good	15–20	Good	15–18	Fair	10–17	Fair	12–15	Poor	
Siberian elm	Good	30–40	Good	30–32	Good	36–40	Fair	17–22	Fair	10–14
Rocky Mountain cedar	Good	15–20	Good	9–15	Good	10–17	Fair	9–12	Fair	5–8
White willow	Good	30–40	Poor		Poor		Poor		Poor	
Shrubs:										
American plum	Good	6–9	Good	6–9	Good	7–9	Poor		Poor	
Buffaloberry	Good	8–11	Good	6–9	Good	7–9	Fair	4–7	Fair	3–4
Caragana	Good	7–9	Good	9–15	Fair	7–9	Fair	4–7	Fair	5–8
Common chokecherry	Good	8–11	Good	9–15	Good	10–17	Poor		Poor	
Cotoneaster	Good	6–9	Good	6–9	Good	4–7	Poor		Poor	
Honeysuckle	Good	7–9	Good	6–9	Good	7–9	Fair	4–7	Poor	
Lilac	Good	6–9	Good	6–9	Fair	4–7	Fair	4–7	Fair	3–4
Nanking cherry	Good	6–9	Fair	4–5	Fair	4–7	Poor		Poor	
Russian-olive	Fair	15–20	Fair	15–18	Fair	17–26	Fair	12–15	Fair	8–10

The windbreak suitability groups in which the soils of Sully County are placed are described in the following paragraphs. Windbreak groups are not numbered consecutively because not all of the groups in the statewide system are present in Sully County. The names of the soil series are mentioned in each group, but this does not mean that all the soils of a given series are in the group. To find the windbreak group of a given soil, refer to the "Guide to Mapping Units."

WINDBREAK GROUP 1

In this group are deep, moderately well drained, silty soils of the Onita series. The surface layer is silt loam, and the subsoil is silty clay loam and silty clay.

These soils are high in content of organic matter and fertility, and the available water capacity is high. They receive additional moisture in the form of runoff water from adjacent soils. These soils have the most favorable moisture regime of all soils in the county for planting trees.

Soils of this group are well suited to the planting of trees for the protection of fields, farmsteads, and feedlots. They are also well suited to recreation, wildlife, and beautification plantings.

WINDBREAK GROUP 3

This group consists of deep, well-drained, nearly level to sloping or undulating, silty and loamy soils of the Agar, Eakin, Glenham, Highmore, Java, Lowry, Peno, Raber, and Ree series. These soils have a surface layer of silt loam or loam and a subsoil of silty clay loam or clay loam, except for Lowry soils. Lowry soils have a subsoil of silt loam.

Most of these soils are moderate in content of organic matter and medium in fertility. Permeability is moderate to moderately slow. Available water capacity is moderate to high.

Soils of this group are well suited to all types of tree plantings. Site preparation includes fallowing during the year prior to planting. Contour planting helps to conserve moisture in sloping areas.

WINDBREAK GROUP 4

This group consists of deep and moderately deep, moderately well drained and well drained, nearly level to sloping soils of the Demky, Oko, Opal, Promise, and Walke series. The surface layer ranges from loam to clay, and the subsoil from heavy clay loam or silty clay loam to clay. Salts commonly are in the underlying material.

Available water capacity ranges from low to high, but permeability is slow or very slow. The compact, slowly permeable or clayey subsoil somewhat restricts the development of tree roots.

Soils of this group are moderately suited to field, farmstead, and feedlot windbreaks. They are also moderately well suited to use for recreation, wildlife, and beautification plantings, although the height of plants may be less than desired. Fallow is a necessary part of site preparation. Contour planting helps to conserve moisture in sloping areas of the Oko, Opal, and Promise soils.

WINDBREAK GROUP 6

This group consists of well-drained, nearly level to gently sloping, silty and loamy soils of the Alaska and Oahe series. They have a subsoil of silty clay loam or clay loam, but sand and gravel are at a depth of 20 to 40 inches.

These soils are moderate in content of organic matter and medium in fertility. Permeability is rapid in the sand and gravel but moderate in the other parts of the profile. Available water capacity is low to moderate, and the soils are somewhat droughty. The root zone is restricted because the available water capacity of the sand and gravel is very low.

Soils of this group are poorly suited to windbreak plantings. They can be used for all types of plantings where optimum growth is not required or where supplemental moisture is available. Fallow is a necessary part of site preparation. Contour planting helps to conserve needed moisture.

WINDBREAK GROUP 9

This group consists of deep, moderately well drained, claypan soils of the Cavo and DeGrey series. Soil reaction is neutral in the surface layer and moderately alkaline in the subsoil and underlying material. The claypan subsoil contains sodium, and the underlying material commonly has moderate amounts of salts.

These soils have slow to very slow permeability. Available water capacity is moderate to high, but the claypan subsoil releases moisture slowly to plants and restricts the development of root systems. The claypan subsoil and the presence of salts are unfavorable for many species.

Soils of this group are poorly suited to windbreak plantings. They can be used for other types of plantings where growth and vigor are less critical.

WINDBREAK GROUP 10

This group consists of soils of the Betts, Dupree, Durrstein, Egas, Elpam, Gettys, Hoven, Hurley, Jerauld, Macken, Oko, Opal, Sully, and Talmo series. Also included are the land types Clayey alluvial land and Saline and alkali land.

These soils are too shallow, steep, stony, wet, or saline for windbreaks that normally would be planted with machinery. They can be used for recreation, wildlife, and beautification plantings that are hand planted and given special care. The trees and shrubs used need to be selected for their tolerance to the conditions present at a given site.

Use of the Soils for Wildlife [7]

Soils can be managed specifically for wildlife. Production of wildlife also can be a byproduct when soils are managed for other uses. In either case, habitat containing food and cover governs the level of production of adapted wildlife. A specific kind of wildlife may require several kinds of habitat to meet its individual needs. Nesting sites are different from loafing areas, and protective vegetation may be other than that providing food. The nature and adequacy of wildlife habitat is closely related to the suitability of a soil for growing the kind of plant that makes up the habitat of a specific kind of wildlife.

In the following paragraphs, the 9 soil associations of Sully County are grouped into 5 wildlife areas which

[7] By JOHN B. FARLEY, biologist, Soil Conservation Service.

differ in potential, species, and environmental factors. Wildlife as discussed here refers primarily to game species.

The Dupree soil association makes up the first wildlife area. Topography is sloping to steep. Almost all of the area is in native grass, but many of the narrow draws and canyons in the area have scattered trees and shrubs. Prior to the flooding of the Missouri River bottom lands by Lake Oahe, this area supplemented the habitat that was present on the wooded bottom lands. The forming of Lake Oahe caused deer, bobcat, and other fur-bearing animals to relocate in this wildlife area.

The woody draws provide good habitat for white-tailed and mule deer as well as for sharp-tailed grouse, mourning dove, and a few pheasants. Predator species present include coyote and bobcat. Ponds constructed for livestock have good secondary benefits for wildlife. They provide brood habitat for ducks and also fisheries for largemouth bass, bluegill, and bullhead. Some of the ponds are suitable for the development of trout fisheries.

The second wildlife area is the Agar-Onita soil association. The major soils in the association are deep, nearly level to sloping, silty soils that formed in loess. This is the most intensively farmed area in the county. About 75 percent of the association is cultivated. Naturally occurring trees are scarce; but windbreaks, planted to protect fields, farmsteads, or feedlots, are present in almost every section of the area.

This wildlife area has a high potential for farm game habitat, particularly for pheasant, mourning dove, and cottontail. There has been an increase of deer and small mammals in the area because of their migration from the Missouri River bottom lands that were inunduated by Lake Oahe. Small depressions where ponds form in spring provide courting and breeding areas for ducks. Farm ponds for livestock water are used by local as well as migrating ducks and geese. The fall population of ducks and geese resting on Lake Oahe feed in large numbers in cornfields and small grain stubble fields in the area. Managing these fields to attract ducks and geese can be a profitable secondary enterprise for many of the farmers in the area.

The third wildlife area consists of the Betts-Durrstein and the Oko soil associations. Many of the soils in this area are rolling to hilly and are too erodible or, in places, too stony for cultivation. Other areas are too poorly drained and too high in content of salts to be satisfactory for cultivation. Most of this wildlife area is in native grass with a few trees in some draws and ravines and along Okobojo and North Medicine Knoll Creeks. The potential for farm game habitat is relatively low, but the area provides cover and water for deer. Farm ponds and dugouts provide water and shoreline vegetation for waterfowl and fur-bearing animals.

The fourth wildlife area consists of the Highmore-Eakin and the Highmore-Raber-Cavo soil associations. Slopes mostly are nearly level to undulating. About 65 percent of this wildlife area is cultivated. The well-balanced combination of corn, small grain, tame grasses, and legumes with native grassland and numerous windbreak plantings is well suited to pheasants, sharp-tailed grouse, and a small number of gray partridge. The windbreak plantings, together with scattered marshes and intermittent lakes or ponds, provide habitat for deer. The marshes, intermittent lakes or ponds, and small depressions that pond in spring provide courting, breeding, and brood-rearing habitat for ducks. Farm ponds and dugouts constructed for livestock water also contribute to duck production. Migratory ducks feed extensively in corn and stubble fields throughout this wildlife area during the fall months.

The fifth wildlife area consists of the Glenham-Hoven, Oahe-Talmo, and Raber-Glenham soil associations. Much of this area is gently undulating to undulating, and a few areas are hilly. Slopes are short and irregular and erosion-control practices are difficult to apply. Numerous

TABLE 4.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear in the first column of this table. The symbol < means less than. The symbol > means more than.

Soil series and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal high water table		Dominant USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
*Agar: AaA, AaB, AaC, AdA, AeA, AeB, AeC, AgA, AkA. For DeGrey part of AdA; Eakin part of AeA, AeB, and AeC; Onita part of AgA; and Walke part of AkA, see DeGrey, Eakin, Onita, and Walke series, respectively.	>5	>5	0–5	Silt loam	ML or CL	A–4 or A–6
			5–18	Silty clay loam	CL or ML–CL	A–6 or A–7
			18–34	Silty clay loam	CL or ML–CL	A–6 or A–7
			34–60	Silt loam	ML	A–4 or A–6
Akaska: AlA, AlB	>5	>5	0–6	Silt loam	ML or CL	A–4 or A–6
			6–14	Silty clay loam	CL or ML–CL	A–6 or A–7
			14–37	Silty clay loam	ML–CL or CL	A–6 or A–7
			37–60	Sand and gravel	GP or GM	A–1 or A–2
Betts: BeE	>5	>5	0–2	Loam	ML or CL	A–4 or A–6
			2–21	Clay loam	CL or ML–CL	A–6 or A–7
			21–60	Clay loam	CL or ML–CL	A–6 or A–7

small depressions that pond in spring and a few lakes and marshes are in the area. About 25 percent of the area is cultivated; the balance, except for farmstead windbreak plantings, is in native grass.

Habitat conditions are favorable for pheasant, which are numerous in this area. Deer are throughout but are most numerous in areas near North Medicine Knoll Creek and around Stone and Cottonwood Lakes. The small depressions, lakes, and marshes and the farm ponds and dugouts constructed for livestock water provide habitat for ducks, as well as resting areas for migrating ducks. Stone Lake and Cottonwood Lake are heavily used by migrating ducks, especially in years when the water levels are high. In good years ducks use the lakes as rest areas, and they feed in nearby cornfields, thus enhancing field and pass-shooting opportunities in nearby areas. Stone Lake has excellent growths of emergent aquatic vegetation, but it lacks permanent open water and submerged aquatic vegetation. Its potential for waterfowl could be increased by a system of ditches and dikes. Besides serving as a production habitat and refuge area for ducks, Cottonwood Lake also provides pan fishing recreation. Yellow perch, bullhead, walleye, and channel catfish are the main species.

Engineering Uses of the Soils [8]

This section provides information of interest to engineers, contractors, farmers, and others who use soil as structural material or as foundation material upon which structures are built. This information also is useful to planning commissions, town and country planners, sanitarians, land developers, architects, and realtors who are concerned with soils and their limitations in land-use planning and development.

[8] By LEONARD P. KUCK, agricultural engineer, Soil Conservation Service.

Among the properties that are important in the design, construction, and maintenance of engineering structures are permeability, shear strength, density, shrink-swell potential, available water capacity, grain-size distribution, plasticity, and reaction. Also important are depth to water table, depth to bedrock, topography, and susceptibility to flooding.

The estimates and interpretations of soil properties given in this section can be used in:

1. Selecting potential residential, industrial, commercial, and recreational areas.
2. Selecting potential locations for roads, streets, highways, airports, pipelines, and underground cables.
3. Locating probable sources of sand, gravel, or roadfill suitable for use as construction material.
4. Planning and designing agricultural drainage systems, farm ponds and dugouts, irrigation systems, terraces, diversions, and other structures for controlling water and conserving water.
5. Determining areas that have severe hazards for polluting ground water supplies and for polluting stream water.

The engineering interpretations reported here do not eliminate the need for sampling and testing at the site of specific engineering works that involve heavy loads and where excavations are deeper than the depths of soil layers here reported. Even in these situations, the soil map is useful in planning more detailed field investigations and for indicating the kinds of problems that may be expected.

Most of the information in this section is in tables 4, 5, 6, and 7. Some terms used in soil science have different meanings from those of identical terms used in engineering. Examples are sand, silt, and clay. These and other terms used by soil scientists are defined in the Glossary at the back of this survey.

significant to engineering

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for For detailed descriptions of soils, see the section "Descriptions of the Soils." Absence of data indicates that no estimate was made]

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					Uncoated steel	Concrete
				In./hr.	*In./in. of soil*	*pH*			
100	100	90–100	70–90	1. 2–2. 0	0. 19–0. 22	6. 1–6. 5	Low	Low	Low.
100	100	95–100	80–95	0. 6–1. 2	0. 19–0. 22	6. 6–7. 3	Moderate	Moderate	Low.
100	100	95–100	80–95	0. 6–1. 2	0. 17–0. 20	7. 4–8. 4	Moderate	Moderate	Low.
100	100	90–100	70–100	0. 6–2. 0	0. 17–0. 20	7. 9–9. 0	Low	Moderate	Low.
100	100	90–100	70–90	1. 2–2. 0	0. 19–0. 22	6. 6–7. 3	Low	Low	Low.
100	100	95–100	85–95	0. 6–1. 2	0. 19–0. 22	6. 6–7. 3	Moderate	Moderate	Low.
100	100	95–100	85–95	0. 6–1. 2	0. 17–0. 20	7. 4–8. 4	Moderate	Moderate	Low.
45–80	40–70	20–40	10–30	6. 0–10. 0	0. 03–0. 06	6. 6–7. 3	Low	Low	Low.
95–100	85–100	75–95	60–75	1. 2–2. 0	0. 18–0. 20	6. 6–7. 3	Low	Low	Low.
95–100	85–100	75–95	50–90	0. 6–1. 2	0. 17–0. 20	7. 9–8. 4	Moderate	Moderate	Low.
95–100	85–100	75–95	50–90	0. 2–0. 6	0. 17–0. 20	7. 9–8. 4	Moderate	Moderate	Moderate.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal high water table		Dominant USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
Cavo [1] Mapped only in complexes with Raber soils.	>5	>5	0–6 6–13 13–60	Loam Clay loam Clay loam	ML or CL CH or CL CH or CL	A–4 or A–6 A–7 A–6 or A–7
Clayey alluvial land: Cd. Too variable to be rated.						
DeGrey [1] Mapped only in complexes with Agar, Highmore, and Onita soils.	>5	>5	0–6 6–19 19–36 36–60	Silt loam Silty clay Silty clay loam Clay loam	ML or CL CH CL or CH CL or CH	A–4 or A–6 A–7 A–7 or A–6 A–6 or A–7
Demky [1] Mapped only in complexes with Jerauld and Raber soils.	>5	>5	0–8 8–36 36–60	Loam Clay loam Clay loam	ML or CL CL or CH CL or CH	A–4 or A–6 A–7 or A–6 A–7 or A–6
*Dupree: DoF, Ds For Opal part of DoF, see Opal series.	<2	>5	0–16 16–60	Clay Shale.	CH or MH	A–7
*Durrstein: Du For Egas part, see Egas series.	>5	3–8	0–3 3–16 16–60	Silt loam Silty clay Silty clay	ML–CL or ML CH CH	A–4 or A–6 A–7 A–7
Eakin Mapped only in complexes with Agar and Highmore soils.	>5	>5	0–7 7–13 13–27 27–60	Silt loam Silty clay loam Silt loam Clay loam	ML or ML–CL CL CL or ML–CL CL	A–4 or A–6 A–6 or A–7 A–6 or A–7 A–6
Egas: Eg	>5	2–5	0–19 19–60	Silty clay Silty clay	CH CH	A–7 A–7
Elpam: Ep	>5	1½–4	0–4 4–52 52–60	Silt loam Silty clay loam Clay loam	ML or ML–CL CL CL	A–4 or A–6 A–6 or A–7 A–6 or A–7
Gettys: GeE	>5	>5	0–3 3–38 38–60	Clay loam Clay loam Clay	CL or ML–CL CL or CH CH or CL	A–6 or A–7 A–6 or A–7 A–7 or A–6
Glenham: GlA, GlB, GlC	>5	>5	0–3 3–9 9–38 38–60	Loam Clay loam Clay loam Clay loam	CL or ML–CL ML–CL or CL CL CL	A–4 or A–6 A–6 or A–7 A–6 or A–7 A–6 or A–7
*Highmore: HcA, HdA, HeA, HeB, HmA For DeGrey part of HdA, Eakin part of HeA and HeB, and Walke part of HmA, see DeGrey, Eakin, and Walke series, respectively.	>5	>5	0–7 7–12 12–25 25–60	Silt loam Silty clay loam Silty clay loam Silt loam	ML or ML–CL CL CL ML or ML–CL	A–4 or A–6 A–6 or A–7 A–6 or A–7 A–6 or A–7
Hoven: Ho [1]	>5	>5	0–4 4–30 30–60	Silt loam Silty clay Clay loam	ML–CL or CL CH or MH CL or CH	A–4 or A–6 A–7 A–7 or A–6

See footnote at end of table.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					Uncoated steel	Concrete
				In./hr.	*In./in. of soil*	*pH*			
100	100	85–95	60–75	1. 2– 2. 0	0. 18–0. 20	6. 6–7. 3	Low	Low	Low.
100	100	90–100	70–80	0. 02– 0. 2	0. 13–0. 16	7. 4–8. 4	High	High	Moderate.
100	100	90–100	70–80	0. 06– 0. 6	0. 14–0. 17	7. 9–8. 4	Moderate to high.	High	High.
100	95–100	95–100	85–100	1. 2– 2. 0	0. 19–0. 22	6. 6–7. 3	Low	Low	Low.
100	95–100	95–100	80–100	0. 02– 0. 2	0. 10–0. 15	7. 9–8. 4	High	High	Moderate.
100	95–100	95–100	80–100	0. 06– 0. 2	0. 11–0. 14	7. 9–8. 4	Moderate to high.	High	Moderate.
100	95–100	90–100	70–80	0. 06– 0. 6	0. 11–0. 14	7. 9–8. 4	Moderate to high.	High	High.
100	100	85–95	60–75	1. 2– 2. 0	0. 18–0. 20	6. 6–7. 3	Low	Low	Low.
100	100	90–100	70–80	0. 06– 0. 2	0. 11–0. 14	7. 4–8. 4	High	High	Moderate.
100	100	90–100	70–80	0. 2– 0. 6	0. 11–0. 14	7. 9–8. 4	Moderate to high.	High	Moderate.
100	100	95–100	95–100	0. 02– 0. 2	0. 08–0. 12	6. 6–7. 8	High	High	Moderate.
100	100	90–100	70–90	0. 6– 1. 2	0. 17–0. 20	6. 6–7. 3	Low	Low	Low.
100	100	90–100	75–95	0. 02– 0. 2	0. 10–0. 15	7. 9–8. 4	High	High	High.
100	100	95–100	90–95	0. 02– 0. 2	0. 08–0. 13	7. 9–8. 4	High	High	High.
100	100	90–100	70–100	1. 2– 2. 0	0. 19–0. 22	6. 6–7. 3	Moderate	Low	Low.
100	100	85–100	70–100	0. 6– 1. 2	0. 17–0. 20	6. 6–7. 8	Moderate	Moderate	Low.
100	100	80–100	70–90	0. 6– 1. 2	0. 17–0. 20	7. 9–8. 4	Moderate	Moderate	Low.
90–100	85–100	90–100	55–90	0. 2– 0. 6	0. 14–0. 17	8. 5–9. 0	High	Moderate	Moderate.
100	100	95–100	90–100	0. 06– 0. 2	0. 10–0. 15	7. 9–8. 4	High	High	High.
100	100	95–100	90–100	0. 06– 0. 2	0. 08–0. 13	7. 9–8. 4	High	High	High.
100	100	95–100	70–90	0. 6 – 1. 2	0. 19–0. 22	7. 9–8. 4	Low	Moderate	Low.
100	100	95–100	85–95	0. 6 – 1. 2	0. 17–0. 20	7. 9–8. 4	Moderate to high.	High	Moderate.
100	100	90–100	70–80	0. 6 – 1. 2	0. 17–0. 20	7. 9–8. 4	Moderate to high.	High	Moderate.
95–100	95–100	95–100	65–80	0. 6 – 1. 2	0. 19–0. 22	7. 4–7. 8	Moderate	Moderate	Low.
95–100	95–100	90–100	70–80	0. 6 – 1. 2	0. 14–0. 17	7. 9–8. 4	High	Moderate	Moderate.
85–100	75–100	70–100	75–95	0. 2 – 0. 6	0. 11–0. 16	7. 9–8. 4	High	Moderate	Moderate.
100	95–100	70–100	60–75	1. 2 – 2. 0	0. 18–0. 20	6. 6–7. 3	Low	Low	Low.
100	95–100	85–100	60–90	0. 6 – 1. 2	0. 19–0. 22	6. 6–7. 3	Moderate	Moderate	Low.
100	85–100	75–100	70–90	0. 6 – 1. 2	0. 17–0. 20	7. 4–8. 4	Moderate	Moderate	Low.
100	85–100	75–100	70–90	0. 2 – 0. 6	0. 17–0. 20	8. 5–9. 0	Moderate	Moderate	Moderate.
100	100	95–100	80–100	1. 2 – 2. 0	0. 19–0. 22	6. 6–7. 3	Low	Low	Low.
100	95–100	95–100	80–100	0. 6 – 1. 2	0. 19–0. 22	6. 6–7. 8	Moderate	Moderate	Low.
100	95–100	95–100	80–100	0. 6 – 1. 2	0. 17–0. 20	7. 4–8. 4	Moderate	Moderate	Low.
100	90–100	90–100	70–90	1. 2 – 2. 0	0. 17–0. 20	7. 9–8. 4	Low to moderate.	Moderate	Low.
100	100	90–100	70–90	0. 6 – 2. 0	0. 19–0. 22	6. 6–7. 3	Low to moderate.	Low	Low.
100	100	95–100	90–100	<0. 06	0. 10–0. 15	7. 4–8. 4	High	High	High.
100	100	90–100	70–80	0. 06– 0. 2	0. 14–0. 17	7. 9–8. 4	Moderate to high.	High	High.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal high water table		Dominant USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
Hurley: HuA [1]	<3½	>5	0–3	Silt loam	ML or ML–CL	A–4 or A–6
			3–10	Silty clay	CH	A–7
			10–32	Silty clay	CH	A–7
			32–60	Shale.		
*Java: JbD, JcD, JgC	>5	>5	0–3	Loam	ML–CL or ML	A–4 or A–6
			3–8	Clay loam	CL or ML–CL	A–6 or A–7
			8–40	Clay loam	CL or ML–CL	A–6 or A–7
			40–60	Clay loam	CL	A–6 or A–7
*Jerauld: JkA [1]	>5	>5	0–3	Loam	ML or ML–CL	A–4 or A–6
For Demky part, see Demky series.			3–9	Clay	CH	A–7
			9–60	Silty clay	CH	A–7
Lowry: LoA, LoB, LoC, LoD	>5	>5	0–8	Silt loam	ML or ML–CL	A–4
			8–60	Silt loam	ML, ML–CL, or CL	A–4 or A–6
Macken: Ma	>5	>5	0–2	Silty clay loam	CL or CH	A–6 or A–7
			2–26	Silty clay	CH	A–7
			26–39	Silty clay	CH	A–7
			39–60	Silty clay loam	CH or CL	A–7
*Oahe: OaA, OaB, OhA, OhB	>5	>5	0–15	Loam and clay loam	ML, CL, or ML–CL.	A–4 or A–6
For Talmo part of OhA and OhB, see Talmo series.			15–25	Loam	ML or ML–CL	A–4 or A–6
			25–60	Sand and gravel	GM, GC, or SM	A–1 or A–2
Oko: OkA, OkB, OkC, OlE	>3	>5	0–7	Clay loam	CL	A–7 or A–6
			7–60	Clay	CH	A–7 or A–6
*Onita: OnA, OnB, OrA, OsA	>5	>5	0–12	Silt loam	ML or CL	A–6
For DeGrey part of OrA and Hoven part of OsA, see DeGrey and Hoven series, respectively.			12–18	Silty clay loam	CL	A–6 or A–7
			18–30	Silty clay	CL or CH	A–6 or A–7
			30–60	Silty clay loam	CL	A–6 or A–7
*Opal: OtB, OtC, OuD	1½–3	>5	0–10	Clay	CH or MH–CH	A–7
For Dupree part of OuD, see Dupree series.			10–32	Clay	CH or MH–CH	A–7
			32–60	Shale.		
Peno	>5	>5	0–3	Loam	ML–CL or CL	A–6
Mapped only in complexes with Raber soils.			3–8	Clay loam	CL or CH	A–6 or A–7
			8–19	Clay loam	CL or CH	A–6 or A–7
			19–60	Clay loam	CL or CH	A–6 or A–7
Promise: PrA, PrB	3½	>5	0–14	Clay	CH or MH–CH	A–7
			14–60	Silty clay	CH or MH–CH	A–7
*Raber: RcA, RcB, RdA, RdB, RgB, RgC, RhA, RhC, RpB, RpC.	>5	>5	0–4	Loam	CL or ML–CL	A–4 or A–6
For Cavo part of RcA and RcB, Demky part of RdA and RdB, Glenham part of RgB and RgC, Highmore part of RhA and RhC, and Peno part of RpB and RpC, see Cavo, Demky, Glenham, Highmore, and Peno series, respectively.			4–13	Clay loam	CL or CH	A–6 or A–7
			13–30	Clay loam	CL	A–6 or A–7

See footnote at end of table.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					Uncoated steel	Concrete
				In./hr.	*In./in. of soil*	*pH*			
100	100	90–100	70–90	0. 6–1. 2	0. 19–0. 22	6. 6–7. 3	Moderate	Low	Low.
100	100	95–100	90–100	<0. 06	0. 07–0. 11	7. 9–8. 4	High	High	High.
100	100	95–100	85–100	<0. 06	0. 05–0. 09	7. 9–8. 4	High	High	High.
100	90–100	85–95	60–75	1. 2– 2. 0	0. 18–0. 20	6. 6–7. 3	Low	Low	Low.
100	90–100	85–100	70–80	0. 6– 1. 2	0. 19–0. 22	6. 6–7. 3	Moderate	Moderate	Low.
100	90–100	85–100	70–80	0. 6– 1. 2	0. 17–0. 20	7. 4–8. 4	Moderate	Moderate	Moderate.
85–100	75–100	65–100	70–80	0. 2– 0. 6	0. 17–0. 20	7. 4–7. 8	Moderate	Moderate	Moderate.
100	100	85–95	70–85	0. 6– 1. 2	0. 19–0. 22	6. 6–7. 3	Low to moderate.	Low	Low.
100	100	90–100	80–95	0. 02– 0. 2	0. 07–0. 11	7. 4–8. 4	High	High	High.
100	100	95–100	90–95	0. 06– 0. 2	0. 08–0. 13	7. 9–9. 0	High	High	High.
100	100	90–100	70–90	1. 2– 2. 0	0. 19–0. 22	6. 6–7. 3	Low	Low	Low.
100	100	90–100	70–90	1. 2– 2. 0	0. 17–0. 20	6. 6–8. 4	Low	Low	Low.
100	100	95–100	85–95	0. 2– 0. 6	0. 16–0. 19	6. 6–7. 3	Moderate to high.	High	Low.
100	100	95–100	90–95	0. 06– 0. 2	0. 10–0. 14	6. 6–7. 8	High	High	Moderate.
100	100	95–100	90–95	0. 06– 0. 2	0. 08–0. 12	7. 9–8. 4	High	High	Moderate.
100	100	95–100	85–95	0. 06– 0. 2	0. 14–0. 17	8. 5–9. 0	High	High	Moderate.
90–100	80–100	60–75	50–85	0. 6– 2. 0	0. 18–0. 20	6. 6–7. 8	Low to moderate.	Low	Low.
90–100	75–100	50–70	50–70	1. 2– 2. 0	0. 16–0. 18	7. 9–8. 4	Low	Low	Low.
45–80	40–75	20–50	0–40	6. 0–10. 0	0. 03–0. 06	7. 9–8. 4	Low	Low	Low.
100	100	90–100	70–80	0. 6– 1. 2	0. 19–0. 22	7. 4–8. 4	Moderate to high.	Moderate	Low.
100	90–100	80–100	75–95	0. 2– 0. 6	0. 11–0. 16	7. 9–8. 4	High	High	Moderate.
100	100	90–100	80–100	0. 6– 2. 0	0. 19–0. 22	6. 6–7. 3	Low to moderate.	Moderate	Low.
100	100	90–100	75–100	0. 2– 0. 6	0. 16–0. 19	6. 6–7. 3	Moderate to high.	Moderate	Low.
100	100	95–100	75–100	0. 2– 0. 6	0. 11–0. 16	6. 6–7. 3	High	Moderate to high.	Low.
100	95–100	85–100	75–100	0. 2– 0. 6	0. 17–0. 20	7. 9–8. 4	Moderate to high.	Moderate to high.	Low.
100	100	95–100	85–100	0. 02– 0. 2	0. 10–0. 14	6. 6–8. 4	High	High	Moderate.
100	100	95–100	85–100	0. 02– 0. 2	0. 08–0. 12	7. 9–8. 4	High	High	Moderate.
100	95–100	85–100	60–90	1. 2– 2. 0	0. 18–0. 20	6. 6–7. 3	Moderate	Low	Low.
100	95–100	90–100	65–90	0. 6– 1. 2	0. 16–0. 19	6. 6–7. 3	High	Moderate	Low.
100	95–100	90–100	65–90	0. 6– 1. 2	0. 14–0. 17	7. 9–8. 4	High	Moderate	Low.
85–100	75–100	70–100	60–90	0. 2– 0. 6	0. 14–0. 17	7. 9–9. 0	High	Moderate	Moderate.
100	100	90–100	75–95	0. 02– 0. 2	0. 10–0. 14	6. 6–8. 4	High	High	Low.
100	100	90–100	75–95	0. 02– 0. 2	0. 08–0. 12	7. 9–8. 4	High	High	Moderate.
80–100	75–100	70–100	60–75	1. 2– 2. 0	0. 18–0. 20	6. 6–7. 3	Low to moderate.	Low	Low.
90–100	80–100	75–100	60–90	0. 06– 0. 6	0. 16–0. 19	7. 4–8. 7	High	Moderate	Low.
90–100	80–100	75–100	60–90	0. 06– 0. 6	0. 14–0. 17	7. 9–8. 4	High	Moderate	Moderate.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal high water table		Dominant USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
*Ree: RrA, RrB, Rt For Durrstein part of Rt, see Durrstein series.	>5	>5	0–6	Loam	CL or ML–CL	A–4 or A–6
			6–18	Clay loam	CL	A–6
			18–46	Clay loam	CL	A–6
			46–60	Loam	CL or ML–CL	A–4 or A–6
Rough broken land: Ru. Too variable to be rated.						
Saline and alkali land: Sa. Too variable to be rated.						
Shale land: St. Too variable to be rated.						
*Sully: SuE, SwD For Lowry part of SwD, see Lowry series.	>3½	>5	0–60	Silt loam	ML	A–4
Talmo: TaE	>5	>5	0–8	Gravelly loam	ML	A–4
			8–60	Sand and gravel	GM, GC, SC, or SM	A–1 or A–2
Walke: [1] Mapped only in complexes with Agar and Highmore soils.	>5	>5	0–7	Silt loam	CL or ML–CL	A–6
			7–15	Silty clay loam	CL or CH	A–7
			15–26	Silty clay loam	CL or CH	A–7
			26–60	Clay loam	CL or CH	A–6 or A–7

[1] Exchangeable sodium exceeds 15 percent in subsoil or substratum.

TABLE 5.—*Interpretations of engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils for referring to other series that

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
*Agar: AaA, AaB, AaC, AdA, AeA, AeB, AeC, AgA, AkA. For DeGrey part of AdA, Eakin part of AeA, AeB, and AeC; Onita part of AgA; and Walke part of AkA, see DeGrey, Eakin, Onita, and Walke series, respectively.	Moderate: moderate permeability.	Moderate to severe: moderate permeability, severe where slopes are more than 6 percent.	Slight	Moderate: moderate shrink-swell potential.	Slight to moderate: silty clay loam texture to a depth of 34 inches.	Severe: AASHO group index more than 8.

See footnotes at end of table.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					Uncoated steel	Concrete
				In./hr.	*In./in. of soil*	*pH*			
100	100	80–100	70–95	1. 2– 2. 0	0. 18–0. 20	6. 6–7. 3	Low to moderate.	Low	Low.
100	90–100	80–100	60–90	0. 6– 1. 2	0. 19–0. 22	6. 6–7. 8	Moderate	Moderate	Low.
100	85–100	70–100	60–90	0. 6– 1. 2	0. 17–0. 20	7. 9–8. 4	Moderate	Moderate	Low.
100	85–100	70–100	60–75	0. 6– 2. 0	0. 16–0. 18	7. 9–8. 4	Low to moderate.	Moderate	Low.
100	100	90–100	70–100	1. 2– 2. 0	0. 17–0. 20	7. 4–8. 4	Low	Low	Low.
70–85	75–85	55–75	50–70	1. 2– 2. 0	0. 18–0. 20	6. 6–8. 4	Low	Low	Low.
40–70	25–60	15–50	5–35	6. 0–10. 0	0. 03–0. 06	7. 9–8. 4	Low	Low	Low.
100	100	90–100	80–100	0. 6– 1. 2	0. 19–0. 22	6. 6–7. 3	Low to moderate.	Low	Low.
100	100	95–100	90–100	0. 06– 0. 2	0. 16–0. 19	6. 6–8. 4	High	High	Moderate.
100	100	95–100	90–100	0. 2– 0. 6	0. 11–0. 14	7. 4–7. 8	High	High	Moderate.
100	95–100	85–100	65–85	0. 2– 0. 6	0. 11–0. 14	7. 4–8. 4	High	High	Moderate.

properties of the soils

in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions appear in the first column of this table]

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: AASHO group index more than 8.	Unsuited	Good to a depth of 5 inches; fair to a depth of 18 inches.	Moderate permeability.	Fair to poor stability and compaction; subject to piping.	Moderate permeability.	High available water capacity; deep rooting zone; moderately slow intake rate.	Moderate permeability; long, uniform slopes.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Akaska: AlA, AlB	Slight [2]	Severe: rapid permeability in substratum.	Severe: sand and gravel at a depth of 20 to 40 inches.	Slight	Severe: sand and gravel at a depth of 20 to 40 inches.	Severe: AASHO group index more than 8 in soil above sand and gravel.
Betts: BeE	Severe: slopes are generally more than 15 percent; moderately slow permeability in substratum.	Severe: slopes are more than 6 percent.	Moderate to severe: slopes.	Moderate to severe: moderate shrink-swell potential; severe where slopes are more than 15 percent.	Moderate: clay loam substratum; slopes.	Moderate to severe: moderate shrink-swell potential; severe where slopes are more than 8 percent.
Cavo Mapped only in complexes with Raber soils.	Severe: slow to very slow permeability.	Slight to moderate: moderate where slopes are more than 2 percent.	Moderate: clay loam subsoil.	Severe: high shrink-swell potential.	Moderate: clay loam substratum, poor cover material.	Severe: CH or CL material; moderate to high shrink-swell potential.
Clayey alluvial land: Cd. Too variable for valid interpretation.						
DeGrey Mapped only in complexes with Agar, Highmore, and Onita soils.	Severe: slow to very slow permeability.	Slight	Moderate: clay loam substratum.	Severe: high shrink-swell potential.	Moderate: silty clay loam and clay loam textures; poor cover material.	Severe: CH and CL material; moderate to high shrink-swell potential.
Demky Mapped only in complexes with Jerauld and Raber soils.	Severe: slow permeability.	Slight to moderate: moderate where slopes are more than 2 percent.	Moderate: clay loam subsoil.	Severe: high shrink-swell potential.	Moderate: Clay loam texture.	Severe: AASHO group index more than 8; high shrink-swell potential.
*Dupree: DoF, Ds For Opal part of DoF, see Opal series.	Severe: slow to very slow permeability; shallow to shale.	Severe: shale at a depth of less than 20 inches.	Severe: clay texture.	Severe: high shrink-swell potential; slopes.	Severe: clay texture; soft shale at a depth of less than 20 inches; some slopes greater than 25 percent.	Severe: high shrink-swell potential.
*Durrstein: Du For Egas part see Egas series.	Severe: subject to flooding; slow to very slow permeability.	Severe: subject to flooding; seasonal high water table at a depth of 3 to 8 feet.	Severe: subject to flooding.	Severe: poorly drained; seasonal high water table at a depth of 3 to 8 feet. Subject to flooding; high shrink-swell potential.	Severe: subject to flooding; seasonal high water table at a depth of 3 to 8 feet. Clay and silty clay texture.	Severe: poorly drained; subject to flooding; high shrink-swell potential.

See footnotes at end of table.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor to a depth of 3 feet; AASHO group index more than 8, good below a depth of 3 feet.	Fair to poor: some fines.	Good to a depth of 6 inches; fair to a depth of 17 inches.	Sand and gravel substratum; high seepage.	Slow permeability when compacted if mixed; fair stability.	Rapid permeability in substratum.	Moderate availlable water capacity; moderate intake rate.	Sand and gravel at a depth of 20 to 40 inches.
Fair to poor: slope; plastic material.	Unsuited	Poor: thin	Slopes; moderate to moderately slow permeability.	Fair to good stability and compaction.	Rapid surface runoff; sloping to steep.	Not irrigable; slopes; erodible.	Short, irregular slopes; erodible; stones in some areas.
Fair to poor: moderate to high shrink-swell potential.	Unsuited	Poor: thickness not more than 6 inches.	Slow to very slow permeability; low seepage.	Fair stability and compaction.	Slow to very slow permeability.	Not irrigable; claypan subsoil; susceptible to salt accumulation.	Slow to very slow permeability.
Fair to poor: moderate to high shrink-swell potential.	Unsuited	Poor: thickness not more than 6 inches.	Slow to very slow permeability.	Fair stability and compaction.	Slow to very slow permeability	Not irrigable; claypan subsoil; susceptible to salt accumulation.	Slow to very slow permeability.
Poor: high shrink-swell potential.	Unsuited	Fair: thickness not than 8 inches.	Slow and moderately slow permeability.	Fair stability and compaction; medium to high compressibility.	Slow permeability.	Slow intake rate; salt accumulation possible in substratum.	Slow permeability.
Poor: high shrink-swell potential.	Unsuited	Poor: clay texture.	Shale at a shallow depth; possible seepage in shale fractures.	Fair to poor stability and compaction; susceptible to sliding.	Sloping to steep; shale at a shallow depth; slow to very slow permeability.	Not irrigable; sloping to steep; shale at a shallow depth.	Shale at a shallow depth.
Poor: poorly drained; high shrink-swell potential.	Unsuited	Poor: poorly drained; salts.	Good site for dugouts; seasonal high water table at a depth of 3 to 8 feet.	Fair to poor stability and compaction; high compressibility.	Subject to flooding; seasonal high water table at a depth of 3 to 8 feet; slow to very slow permeability.	Not irrigable; claypan subsoil; poorly drained; high in content of salts.	Not applicable.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Eakin Mapped only in complexes with Agar and Highmore soils.	Severe: moderately slow permeability in substratum.	Slight to severe: slight where slopes are less than 2 percent; severe where slopes are more than 6 percent.	Moderate: clay loam substratum.	Moderate: moderate to high shrink-swell potential.	Moderate: clay loam substratum.	Severe: AASHO group index more than 8; moderate to high shrink-swell potential.
Egas: Eg	Severe: subject to flooding; seasonal high water table; slow permeability.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: poorly drained; seasonal high water table; subject to flooding; high shrink-swell potential.	Severe: subject to flooding; seasonal high water table; silty clay texture.	Severe: poorly drained; subject to flooding; high shrink-swell potential.
Elpam: Ep	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: poorly drained; seasonal high water table; subject to flooding.	Severe: subject to flooding; seasonal high water table.	Severe: poorly drained; subject to flooding.
Gettys: GeE	Severe: slopes generally more than 15 percent; moderately slow permeability in substratum.	Severe: slopes	Moderate to severe: clay loam texture; severe where slopes are more than 15 percent.	Severe: high shrink-swell potential; some slopes more than 15 percent.	Moderate: clay loam texture.	Severe: AASHO group index more than 8; high shrink-swell potential.
Glenham: GlA, GlB, GlC.	Severe: moderately slow permeability in substratum.	Slight to severe: slight where slopes are less than 2 percent; severe where slopes are more than 6 percent.	Moderate: clay loam substratum.	Moderate: moderate shrink-swell potential.	Moderate: clay loam substratum.	Moderate: moderate shrink-swell potential.
*Highmore: HcA, HdA, HeA, HeB, HmA. For DeGrey part of HdA, Eakin part of HeA and HeB, and Walke part of HmA, see DeGrey, Eakin, and Walke series, respectively.	Moderate: moderate permeability.	Moderate to severe: moderate permeability; severe where slopes are more than 6 percent.	Slight	Moderate: moderate shrink-swell potential.	Slight to moderate: silty clay loam between a depth of 7 and 25 inches.	Severe: AASHO group index more than 8.
Hoven: Ho	Severe: subject to frequent flooding; very slow permeability.	Severe: subject to frequent flooding.	Severe: subject to frequent flooding.	Severe: subject to frequent flooding; high shrink-swell potential.	Severe: subject to frequent flooding; silty clay subsoil.	Severe: poorly drained; subject to frequent flooding; AASHO group index more than 8.

See footnotes at end of table.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: AASHO group index more than 8.	Unsuited	Good to a depth of 7 inches, fair to a depth of 13 inches.	Moderately slow permeability in substratum.	Fair to good stability and compaction; medium to high compressibility.	Moderately slow permeability in substratum.	High available water capacity; slow intake rate; possible salt accumulation in substratum.	Smooth plane and convex slopes; moderate permeability.
Poor: poorly drained; high shrink-swell potential.	Unsuited	Poor: poorly drained; salts.	Good site for dugouts; seasonal high water table.	Fair to poor stability and compaction; high compressibility.	Subject to flooding; seasonal high water table; slow permeability.	Not irrigable; poorly drained; high in content of salts.	Not applicable.
Poor: poorly drained.	Unsuited	Poor: poorly drained.	Good site for dugouts; seasonal high water table.	Fair to good stability and compaction.	Seasonal high water table; wet areas lower than available outlets.	Not irrigable; seasonal high water table.	Not applicable.
Poor: AASHO group index more than 8; high shrink-swell potential.	Unsuited	Poor: thin	Slopes; moderately slow permeability in substratum.	Fair to good stability and compaction; medium to high compressibility.	Sloping to steep; rapid surface runoff; moderately slow permeability in substratum.	Not irrigable; undulating to hilly; erodible.	Undulating to hilly; convex slopes; erodible.
Fair: moderate shrink-swell potential.	Unsuited	Good to a depth of 3 inches; fair to a depth of 13 inches.	Moderately slow permeability in substratum.	Fair to good stability and compaction.	Moderately slow permeability in substratum.	High available water capacity; irregular slopes; possible salt accumulations in substratum.	Nearly level to undulating; convex slopes; moderate permeability.
Poor: AASHO group index more than 8.	Unsuited	Good to a depth of 7 inches; fair to a depth of 17 inches.	Moderate permeability; seepage in places.	Fair stability and compaction; subject to piping.	Moderate permeability.	High available water capacity; moderately slow intake rate.	Slopes mostly moderately long and smooth and plane to convex; moderate permeability.
Poor: poorly drained; AASHO group index more than 8; high shrink-swell potential.	Unsuited	Poor: thin; poorly drained.	Good site for dugouts.	Poor stability and compaction; high compressibility.	Very slow permeability; wet areas lower than available outlets.	Not irrigable; poorly drained; claypan subsoil.	Not applicable.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Hurley: HuA	Severe: very slow permeability; shale at a depth of 20 to 40 inches.	Severe: shale at a depth of 20 to 40 inches.	Severe: clay texture.	Severe: high shrink-swell potential.	Severe: clay texture; soft shale at a depth of 20 to 40 inches.	Severe: high shrink-swell potential; AASHO group index more than 8.
*Java: JbD, JcD, JgC. For Betts part of JbD and JcD and Glenham part of JgC, see Betts and Glenham series, respectively.	Severe: moderately slow permeability in substratum.	Moderate to severe: severe where slopes are more than 6 percent.	Moderate: clay loam substratum.	Moderate: moderate shrink-swell potential.	Moderate: clay loam substratum.	Severe: AASHO group index more than 8.
*Jerauld: JkA For Demky part, see Demky series.	Severe: slow to very slow permeability.	Slight	Severe: silty clay subsoil.	Severe: high shrink-swell. potential.	Severe: silty clay subsoil.	Severe: high shrink-swell potential; AASHO group index more than 8.
Lowry: LoA, LoB, LoC, LoD.	Slight to moderate; some slopes are more than 8 percent.	Moderate to severe: moderate permeability; severe where slopes are more than 6 percent.	Slight to moderate: moderate where slopes are more than 9 percent.	Slight to moderate; moderate where slopes are more than 9 percent.	Slight	Moderate: AASHO group index 4 to 8; high frost-action potential.
Macken: Ma	Severe: subject to frequent flooding; slow permeability.	Severe: subject to frequent flooding.	Severe: subject to frequent flooding; silty clay subsoil.	Severe: subject to frequent flooding; high shrink-swell potential.	Severe: subject to frequent flooding; silty clay subsoil.	Severe: poorly drained; subject to frequent flooding; high shrink-swell potential.
*Oahe: OaA, OaB, OhA, OhB. For Talmo part of OhA and OhB, see Talmo series.	Slight [2]	Severe: rapid permeability in substratum.	Severe: sand and gravel at a depth of 20 to 40 inches.	Slight	Severe: sand and gravel at a depth of 20 to 40 inches.	Moderate: AASHO group index 4 to 8 in soil above sand and gravel.
Oko: OkA, OkB, OkC, OlE.	Severe: moderately slow permeability.	Slight to severe: slight where slopes are less than 2 percent; severe where slopes are more than 6 percent.	Severe: clay subsoil.	Severe: high shrink-swell potential.	Severe: clay subsoil.	Severe: AASHO group index more than 8; high shrink-swell potential.
*Onita: OnA, OnB, OrA, OsA. For DeGrey part of OrA and Hoven part of OsA, see DeGrey and Hoven series, respectively.	Severe: subject to excess runoff water from higher slopes; moderately slow permeability.	Slight	Moderate: subject to runoff water from higher slopes.	Moderate: moderately well drained; moderate to high shrink-swell potential.	Severe: subject to runoff water from higher slopes.	Severe: moderate to high shrink-swell potential; AASHO group index more than 8.

See footnotes at end of table.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuited	Poor: thin	Possible seepage in underlying shale.	Fair to poor stability and compaction; high compressibility.	Very slow permeability; moderate depth to shale.	Not irrigable; claypan subsoil; salts.	Claypan subsoil; very slow permeability.
Poor: AASHO group index more than 8.	Unsuited	Good to a depth of 3 inches; fair below; clay loam texture.	Moderately slow permeability in substratum; slopes.	Fair stability and compaction; medium compressibility.	Moderately slow permeability in substratum.	Short, irregular slopes; moderately slow intake rate.	Gently undulating to rolling, short, irregular, convex slopes; moderate permeability; stones in places.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuited	Poor: thin	Slow to very slow permeability; low seepage rate.	Fair to poor stability and compaction; high compressibility.	Slow to very slow permeability.	Not irrigable; claypan subsoil; susceptible to salt accumulation.	Claypan subsoil; slow to very slow permeability.
Poor: high frost-action potential.	Unsuited	Good to a depth of 16 inches.	Moderate permeability.	Poor stability and compaction; piping hazard.	Moderate permeability.	High available water capacity; moderate intake rate; erodible.	Long, smooth slopes; moderate permeability; erodible.
Poor: poorly drained; high shrink-swell potential.	Unsuited	Poor: poorly drained; clay texture.	Good site for dugouts.	Fair to poor stability and compaction; high compressibility.	Slow permeability; wet areas lower than available outlets.	Not irrigable; poorly drained.	Not applicable.
Good	Fair to poor: some fines.	Fair: limited to a depth of 15 inches.	Sand and gravel substratum; high seepage.	Slow to moderate permeability when compacted if mixed; fair to good stability.	Rapid permeability in substratum.	Low to moderate available water capacity; moderate intake rate.	Sand and gravel at a depth of 20 to 40 inches
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuited	Poor: limited to a depth of 7 inches; some slopes more than 15 percent.	Moderately slow permeability.	Fair to poor stability and compaction; high compressibility.	Moderately slow permeability; nearly level to hilly.	Slow intake rate; nearly level to hilly.	Nearly level to hilly; moderately slow permeability; stones in places.
Fair to poor: moderate to high shrink-swell potential.	Unsuited	Good to a depth of 12 inches, fair to a depth of 18 inches.	Moderately slow permeability.	Fair to good stability and compaction; medium to high compressibility.	Moderately slow permeability.	High available water capacity; moderately slow intake rate.	Concave to plane slopes; moderately slow permeability.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
*Opal: OtB, OtC, OuD— For Dupree part of OuD, see Dupree series.	Severe: slow to very slow permeability; shale at a depth of 20 to 40 inches.	Severe: shale at a depth of 20 to 40 inches.	Severe: clay texture.	Severe: high shrink-swell potential; some slopes more than 15 percent.	Severe: clay texture; soft shale at a depth of 20 to 40 inches.	Severe: high shrink-swell potential.
Peno——— Mapped only in complexes with Raber soils.	Severe: moderately slow permeability in substratum.	Moderate to severe: slopes.	Moderate: clay loam subsoil.	Severe: high shrink-swell potential.	Moderate: clay loam subsoil.	Severe: high shrink-swell potential; AASHO group index more than 8.
Promise: PrA, PrB—	Severe: slow to very slow permeability.	Slight to severe: slight where slopes are less than 2 percent; severe where slopes are more than 6 percent.	Severe: clay texture.	Severe: high shrink-swell potential.	Severe: clay texture.	Severe: high shrink-swell potential; AASHO group index more than 8.
*Raber: RcA, RcB, RdA, RdB, RgB, RgC, RhA, RhC, RpB, RpC. For Cavo part of RcA and RcB, Demky part of RdA and RdB, Glenham part of RgB and RgC, Highmore part of RhA and RhC, and Peno part of RpB and RpC, see Cavo, Demky, Glenham, Highmore, and Peno series, respectively.	Severe: moderately slow permeability.	Slight to severe: slight where slopes are less than 2 percent; severe where slopes are more than 6 percent.	Moderate: clay loam subsoil.	Severe: high shrink-swell potential.	Moderate: clay loam subsoil.	Severe: AASHO group index more than 8; high shrink-swell potential.
*Ree: RrA, RrB, Rt— For Durrstein part of Rt, see Durrstein series.	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: clay loam subsoil.	Moderate: moderate shrink-swell potential.	Moderate: clay loam subsoil.	Moderate: moderate shrink-swell potential.
Rough broken land: Ru. Too variable for valid interpretation.						
Saline and alkali land: Sa. Too variable for valid interpretation.						

See footnotes at end of table.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: high shrink-swell potential.	Unsuited-----	Poor: clay texture.	Shale at a depth of 20 to 40 inches; seepage in places.	High compressibility; fair to poor stability and compaction.	Slow to very slow permeability; shale at a depth of 20 to 40 inches.	Not irrigable; shale at a depth of 20 to 40 inches; low available water capacity.	Shale at a depth of 20 to 40 inches.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuited-----	Poor: limited to a depth of 8 inches.	Moderately slow permeability.	Fair to poor stability and compaction; medium to high compressibility.	Moderately slow permeability in substratum.	Gently undulating to undulating; moderately slow intake rate.	Mostly short, irregular, convex slopes; moderate to moderately slow permeability.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuited-----	Poor: clay texture.	Slow permeability; low seepage.	Fair to poor stability and compaction; high compressibility.	Slow to very slow permeability.	Low to moderate available water capacity; very slow intake rate.	Long, plane to slightly concave slopes; slow to very slow permeability.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuited-----	Fair to a depth of 14 inches.	Moderately slow to slow permeability.	Fair stability and compaction; medium to high compressibility.	Moderately slow to slow permeability.	Moderate to high available water capacity; slow intake rate; nearly level to undulating; salt accumulation in substratum in places.	Smooth, plane and short, irregular, convex slopes; moderately slow to slow permeability.
Fair: moderate shrink-swell potential.	Poor: source below a depth of 5 feet in places.	Good to a depth of 6 inches, fair to a depth of 18 inches.	Moderate permeability; seepage in substratum in places.	Fair stability and compaction; medium to high compressibility.	Moderate permeability.	Moderate permeability; high available water capacity.	Long, smooth slopes; moderate permeability.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Shale land: St. Too variable for valid interpretation.						
Sully: SuE, SwD—For Lowry part of SWE, see Lowry series.	Moderate: moderate permeability; slopes.	Moderate to severe: slopes.	Slight to severe: slight where slopes are less than 9 percent; severe where slopes are more than 15 percent.	Slight to severe: slight where slopes are less than 9 percent; severe where slopes are more than 15 percent.	Slight to moderate: moderate where slopes are more than 15 percent.	Moderate: AASHO group index 4 to 8.
Talmo: TaE	Slight to severe: [2] slight where slopes are more than 8 percent; severe where slopes are more than 15 percent.	Severe: rapid permeability.	Severe: sand and gravel at a depth of less than 12 inches.	Slight to severe: slight where slopes are less than 9 percent; severe where slopes are more than 15 percent.	Severe: sand and gravel below a depth of 8 inches.	Slight to severe: slight where slopes are less than 8 percent; severe where slopes are more than 15 percent.
Walke—Mapped only in complexes with Agar and Highmore soils.	Severe: slow permeability.	Slight	Moderate: clay loam below a depth of 26 inches.	Severe: high shrink-swell potential.	Moderate: silty clay loam and clay loam below a depth of 7 inches.	Severe: AASHO group index more than 8; high shrink-swell potential.

[1] Onsite studies of the underlying strata, water tables, and hazards of aquifer pollution and drainage into ground water need to be made for landfills deeper than 5 or 6 feet.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: AASHO group index 4 to 8.	Unsuited	Poor: thin; low fertility.	Moderate permeability; slopes.	Poor stability and compaction; medium compressibility; piping hazard.	Moderate permeability; gently sloping to moderately steep.	High available water capacity; moderate intake rate; gently sloping to moderately steep; erodible.	Gently sloping to moderately steep convex slopes; moderate permeability; erodible.
Good to poor: good where slopes are less than 15 percent; poor where slopes are more than 25 percent.	Fair to poor: fines.	Poor: thin; gravelly.	Gravelly materials; high seepage.	Stable fill; highly pervious.	Rapid permeability.	Not irrigable; low to very low available water capacity; rapid intake rate; gravelly.	Sand and gravel at a very shallow depth.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuited	Fair: limited to a depth of 9 inches.	Moderately slow permeability in substratum; low seepage.	Fair to poor stability and compaction; medium to high compressibility.	Moderately slow to slow permeability.	Slow intake rate; salt accumulation in substratum in places.	Moderately slow to slow permeability.

[2] Possible source of pollution for domestic water supplies.

TABLE 6.—

Soil name and location	Parent material	Report No.	Depth	Moisture-density [1]	
				Maximum dry density	Optimum moisture
			In.	*Lbs./cu. ft.*	*Pct.*
Dupree clay: 351 feet W. and 240 S. of E. quarter corner sec. 2, T. 114 N., R. 81 W.	Pierre shale	152	1½–9	87	29
		153	16–60	87	31
Glenham loam: 112 feet N. and 790 feet E. of SW. corner sec. 2, T. 114 N., R. 74 W.	Glacial till	163	3–9	96	23
		164	18–40	114	14
Hoven silt loam: 260 feet W. and 1,290 feet N. of SE. corner sec. 16, T. 114 N., R. 78 W.	Local alluvium over glacial till.	158	0–4	94	22
		159	4–11	96	23
		160	27–46	107	17
Oahe loam: 1,530 feet W. and 75 feet S. of NE. corner sec. 19, T. 114 N., R. 74 W.	Glacio-alluvial outwash over sand and gravel.	149	3–7	107	16
		150	15–26	121	12
		151	32–45	125	8
Onita silt loam: 1,260 feet E. and 1,220 feet N. of SW. corner sec. 36, T. 114 N., R. 77 W.	Local alluvium	161	11–18	97	23
		162	33–60	107	17

[1] Based on Moisture-density Relations of Soils Using 5.5-lb. Rammer and 12-in. Drop, AASHO Designation T 99, Method A(*1*).
[2] Mechanical analyses according to the AASHO Designation T 88(*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette

TABLE 7.—*Engineering test data for soil samples taken along proposed*

[Tests made by the South Dakota

Soil Series	Horizon	Number of samples tested	Mechanical analysis [1]—Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm.)		No. 40 (0.42 mm.)		No. 200 (0.074 mm.)	
			Range	Average	Range	Average	Range	Average
Agar	A	26	98–100	100	94–100	98	75–100	90
	B	59	97–100	99	93–100	98	81–100	91
	C	90	95–100	99	90–100	97	75–100	90
Betts	C	105	85–100	95	75–100	89	50–90	70
DeGrey	B	22	96–100	99	91–100	97	80–100	92
	C	11	96–100	99	92–100	97	75–100	90
Eakin	A	15	98–100	99	92–100	96	73–99	86
	B	37	95–100	99	86–100	95	71–100	88
	C	13	92–100	97	82–100	92	62–99	80
	2C	65	87–100	96	77–100	90	55–97	76
Gettys	C	22	67–100	91	45–100	80	30–100	69
Glenham	A	10	90–100	96	71–100	90	57–100	79
	B	5	95–100	99	85–100	93	64–93	78
	C	18	85–100	95	77–100	89	51–99	75

See footnotes at end of table.

Engineering test data

Mechanical analysis [2]									Liquid limit	Plasticity index	Classification	
Percentage passing sieve								Percentage smaller than 0.005 mm.			AASHO [3]	Unified [4]
2-in.	1½-in.	1-in.	¾-in.	⅜-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
									Pct.			
------	------	------	------	------	--------	100	99	98	70	78	47	A-7-5(20)	CH
------	------	------	------	------	--------	100	98	96	74	88	50	A-7-5(20)	MH-CH
------	------	------	------	------	100	99	94	81	32	41	17	A-7-6(11)	ML-CL
------	------	100	95	94	93	91	84	67	37	35	15	A-6(8)	CL
------	------	------	------	------	--------	100	99	95	26	36	10	A-4(8)	ML-CL
------	------	------	------	------	--------	--------	100	95	52	53	15	A-7-5(13)	MH
------	------	------	------	------	--------	--------	100	97	32	40	18	A-6(12)	CL
------	100	87	87	85	82	80	64	51	13	38	11	A-6(3)	ML-CL
------	------	100	94	88	81	75	53	34	13	31	10	A-2-4(0)	SM-SC
100	97	82	71	49	35	28	11	4	1	19	2	A-1-a(0)	GW
------	------	------	------	------	--------	--------	100	97	42	45	21	A-7-6(13)	CL
------	------	------	------	------	--------	--------	100	98	40	40	19	A-6(12)	CL

method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

[3] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1, Ed. 8): The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHO Designation M 145-19(*1*).

[4] Based on the Unified Soil Classification System for Roads, Airfields, Embankments, and Foundations (*7*).

highway routes in Sully County and surrounding counties

Department of Highways]

Liquid limit [2]		Plasticity index [3]		Classification			Estimated [7] CBR
Range	Average	Range	Average	AASHO (Old Index [4])	AASHO (New Index [5])	Unified [6]	
Percent	*Percent*						
34-47	41	12-19	15	A-7-6(10)	A-7-6(15)	ML-CL	5
35-46	41	12-27	19	A-7-6(12)	A-7-6(19)	CL	5
32-48	40	9-28	18	A-6(12)	A-6(12)	CL	5
27-54	40	9-34	21	A-6(11)	A-6(13)	CL	5
48-64	56	24-33	33	A-7-6(19)	A-7-6(17)	CH	3
31-65	48	12-43	27	A-7-6(34)	A-7-6(27)	CL	4
35-50	43	11-29	17	A-7-6(11)	A-7-6(16)	ML-CL	4
39-50	44	13-30	21	A-7-6(13)	A-7-6(20)	CL	4
40-59	49	21-37	28	A-7-6(17)	A-7-6(23)	CL	3
35-60	47	16-39	27	A-7-6(17)	A-7-6(20)	CL	4
35-80	57	14-51	32	A-7-6(18)	A-7-6(22)	CH	3
31-51	41	6-30	18	A-7-6(11)	A-7-6(14)	CL	5
26-50	38	9-27	18	A-6(11)	A-6(13)	CL	6
35-51	43	15-30	22	A-7-6(14)	A-7-6(16)	CL	4

TABLE 7.—*Engineering test data for soil samples taken along proposed*

Soil Series	Horizon	Number of samples tested	Mechanical analysis [1]—Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm.)		No. 40 (0.42 mm.)		No. 200 (0.074 mm.)	
			Range	Average	Range	Average	Range	Average
Highmore	A	95	97–100	99	93–100	97	80–99	90
	B	257	95–100	99	90–100	96	74–100	88
	C	169	94–100	98	87–100	95	69–100	86
Hoven	B	10	98–100	100	94–100	98	81–99	90
Hurley	B	10	99–100	100	95–100	99	87–100	96
	C	29	97–100	99	94–100	98	74–100	91
	2C	18	96–100	99	86–100	98	79–100	94
Lowry	A	6	82–100	96	74–100	94	63–100	89
	B	29	99–100	100	93–100	98	63–100	87
	C	31	91–100	99	73–100	95	51–100	85
Oahe	A	18	80–100	95	62–100	84	37–85	61
	B	33	74–100	93	55–100	82	28–91	60
	C	7	91–100	97	83–100	93	18–100	60
	2C	61	36–99	68	12–82	47	0–55	25
Onita	A	29	95–100	99	90–100	97	81–100	91
	B	76	96–100	99	91–100	97	75–100	89
	C	45	94–100	98	85–100	94	65–100	85
Opal	A	51	99–100	100	94–100	98	84–100	93
	B	87	96–100	99	91–100	99	83–100	94
	C	131	99–100	100	96–100	99	89–100	96
	2C	263	97–100	100	93–100	99	86–100	96
Peno	A	12	96–100	99	86–100	93	57–91	74
	B	19	96–100	99	90–98	94	66–89	78
	C	18	74–100	94	62–100	88	46–100	74
Promise	A	37	96–100	99	93–100	98	84–100	93
	B	110	97–100	99	92–100	98	85–100	95
	C	237	99–100	100	93–100	98	86–100	95
	2C	46	98–100	100	96–100	99	91–100	96
Raber	A	14	93–100	98	85–100	93	60–96	78
	B	50	96–100	99	90–100	96	71–99	85
	C	43	93–100	98	86–100	93	63–98	81
Ree	A	5	97–100	99	82–100	92	71–95	83
	B	15	92–100	98	79–100	90	51–92	71
	C	15	86–100	95	72–100	89	47–88	68
Talmo	A	5	72–100	90	53–100	77	22–89	56
	C	17	25–100	73	0–100	52	0–59	24
	2C	29	41–100	75	15–93	54	2–48	25
Walke	A	27	98–100	100	94–100	98	83–100	91
	B	47	95–100	99	90–100	96	77–100	89
	C	14	93–100	98	85–100	94	66–100	84

[1] Mechanical analyses according to the AASHO Designation T 88(*1*). Results by this procedure may differ somewhat from the results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by hydrometer method, and the various grain-size fractions are calculated on the basis of all material up to and including that 3 inches in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from the calculations of grain-size fractions. The mechanical analyses data used in this table are not intended for naming textural classes of soil.

highway routes in Sully County and surrounding counties—Continued

Liquid limit [2]		Plasticity index [3]		Classification			Estimated [7] CBR
Range	Average	Range	Average	AASHO (Old Index [4])	AASHO (New Index [5])	Unified [6]	
Percent	*Percent*						
36–48	42	9–25	17	A–7–6(11)	A–7–6(17)	ML–CL	5
37–52	44	16–32	23	A–7–6(14)	A–7–6(22)	CL	4
36–55	45	16–35	25	A–7–6(15)	A–7–6(22)	CL	4
50–80	65	22–59	40	A–7–6(20)	A–7–6(41)	CH	2
52–92	72	22–63	42	A–7–6(20)	A–7–6(49)	CH	1
40–81	61	20–54	36	A–7–6(20)	A–7–6(37)	CH	2
61–100	80	33–67	50	A–7–5(20)	A–7–5(55)	CH	1
31–43	37	5–16	10	A–4(8)	A–4(10)	ML–CL	6
26–39	33	5–14	9	A–4(8)	A–4(8)	ML–CL	7
20–48	34	3–23	12	A–6(9)	A–6(10)	CL	7
25–54	40	6–18	12	A–6(6)	A–6(6)	ML	5
22–49	36	4–24	14	A–6(7)	A–6(6)	ML–CL	6
0–72	36	0–40	17	A–6(8)	A–6(8)	CL	6
7–47	27	0–23	9	A–2–4(0)	A–2–4(0)	SC	----------
34–50	42	11–24	17	A–7–6(11)	A–7–6(18)	ML–CL	5
37–60	48	14–40	26	A–7–6(16)	A–7–6(25)	CL	4
31–65	48	10–42	25	A–7–6(16)	A–7–6(23)	CL	4
45–79	62	18–46	32	A–7–5(20)	A–7–5(35)	MH–CH	2
53–88	71	29–58	43	A–7–6 20)	A–7–6(47)	CH	1
55–93	74	29–61	44	A–7–6(20)	A–7–6(51)	CH	1
56–98	77	30–65	47	A–7–6(20)	A–7–6(54)	CH	1
32–55	44	9–25	17	A–7–6(11)	A–7–6(13)	ML–CL	4
44–56	50	23–33	28	A–7–6(17)	A–7–6(22)	CL	3
40–60	50	20–38	28	A–7–6(17)	A–7–6(21)	CL	3
45–71	58	18–39	28	A–7–5(19)	A–7–5(31)	MH–CH	2
49–87	68	26–56	41	A–7–6(20)	A–7–6(45)	CH	1
52–85	69	28–54	40	A–7–6(20)	A–7–6(45)	CH	1
56–103	80	32–66	48	A–7–5(20)	A–7–5(56)	CH	1
35–50	42	13–22	17	A–7–6(12)	A–7–6(14)	ML–CL	5
32–62	47	11–39	25	A–7–6(15)	A–7–6(22)	CL	4
32–66	49	13–42	27	A–7–6(17)	A–7–6(23)	CL	3
30–46	38	11–15	12	A–6(9)	A–6(11)	ML–CL	6
31–45	38	13–25	18	A–6(11)	A–6(12)	CL	6
23–49	36	9–29	18	A–6(10)	A–6(11)	CL	6
34–45	40	5–22	13	A–6(6)	A–6(6)	ML–CL	5
3–47	25	0–19	7	A–2–4(0)	A–2–4(0)	SC	----------
7–47	27	0–24	10	A–2–4(0)	A–2–4(0)	SC	----------
34–53	44	6–30	18	A–7–6(12)	A–7–6(19)	ML–CL	4
40–66	53	18–47	32	A–7–6(19)	A–7–6(31)	CH	3
35–65	50	15–44	29	A–7–6(18)	A–7–6(26)	CL	3

[2] Based on AASHO Designation T 89–60 (*1*).
[3] Based on AASHO Designation T 90–61 (*1*).
[4] Based on AASHO Designation M 145–49 (*1*).
[5] Based on AASHO Designation M 145–661 (*1*).
[6] Based on the Unified Soil Classification System for Roads, Airfields, Embankments, and Foundations (*7*).
[7] Estimated values based on relationships between California Bearing Ratio and liquid limit.

Engineering classification systems

Soil scientists classify soils according to texture, color, and structure (*6*). This system is useful as the initial step for making engineering classifications of soils. Additional properties important in engineering must either be estimated or determined by tests. The engineering systems most commonly used to classify soils are the AASHO (*1*) system adopted by the American Association of State Highway Officials, and the Unified system (*7*) used by the Department of Defense, engineers of the Soil Conservation Service, and others.

The AASHO system is used to classify soils according to those properties that affect their use in highway construction. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade use. At the other extreme, the A–7 group, are clay soils that have low strength when wet. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b; A–2–4, A–2–5, A–2–6, A–2–7; and A–7–5 and A–7–6. If soil material is near a classification boundary, it is given a symbol showing both classes, for example, A–2 or A–4. The estimated classification for all soils in the county is given in table 4.

In the Unified system soils are classified according to grain-size distribution, plasticity, liquid limit, and organic matter. The 8 classes of coarse-grained soils are identified as GW, GP, GM, SW, SP, SM, and SC. The 6 classes of fine-grained soils are identified as ML, CL, OL, MH, CH, and OH. Soils that fall into two classes are given a dual classification, for example, ML or CL. Soils that are marginal in plasticity between nonplastic and plastic are given a borderline classification such as ML–CL.

Estimated soil properties significant to engineering

Table 4 gives estimates of some of the soil properties that are important to engineering. The estimates are based on test data from adjacent counties and on knowledge of the soils gained during the course of the survey. A complete description of a profile that is representative for the series is given in the section "Descriptions of the Soils." Some of the terms for properties and data shown are explained in the following paragraphs .

Permeability as used here relates only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage.

Available water capacity is the capacity of a soil to store water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at the wilting point of plants. It is expressed as inches of water per inch of soil. An expanded definition of available water capacity is in the Glossary.

Reaction is the degree of acidity or alkalinity of a soil expressed as a pH value. The pH value and relative terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is an indication of the volume change to be expected of soil material with changes in moisture content. Shrinking and swelling of soil cause much damage to building foundations, roads, and other structures constructed in, on, or with soil materials.

Corrosivity indicates that the potential danger to uncoated steel or concrete structures through chemical action that dissolves or weakens the structural material. Structural materials corrode more easily in some kinds of soil than in others. Extensive installations that intersect soil boundaries or soil horizons are more likely to suffer corrosion than installations in one kind of soil or soil horizon.

Engineering interpretations

Table 5 provides information useful to engineers and others who plan to use soil material in the construction of engineering works. The table gives the degree and kind of limitations of the soils of Sully County for sewage disposal systems, shallow excavations, dwellings with basements, sanitary land fill, and roads and streets. The table also rates the soils as to their suitability as a source for road fill, sand and gravel, and topsoil. In addition table 5 lists the soil features affecting structures constructed for controlling erosion and conserving water. The ratings and other interpretations in this table are based on engineering properties of soils given in table 4, on available test data, and on field experience. The information given applies only to the soil depths indicated in table 4.

Shallow excavations are less than 6 feet deep and pertain to those made for such purposes as basements, ditches, and graves, and for underground cables, pipelines, and sewers.

Sanitary land fill is a method of disposing of solid wastes on or in the soil by spreading the wastes in thin layers, compacting it, and covering it each day in order to provide protection of the environment. Limitations given here are useful in selecting alternative sites. They are not a substitute for investigations made to greater depths.

Limitations listed for roads and streets pertain to the construction and maintenance of improved roads and streets having some kind of all-weather surfacing. They are expected to carry automobile traffic all year but not fast-moving heavy trucks.

The sand and gravel ratings are based on the probability that the areas shown on the soil map contain deposits of sand and gravel. The ratings do not indicate quality or size of the deposits.

Engineering test data

Tables 6 and 7 contain results of engineering tests performed by the South Dakota Department of Highways on soils in Sully County and surrounding counties. Table 6 contains the results of tests at specific locations in the county. Table 7 contains the results of tests performed along proposed highway routes in surrounding counties. The particle-size distribution and other properties significant in soil engineering are shown in these tables. Some of the terms used in tables 6 and 7 are explained in the following paragraphs.

Maximum dry density is the maximum unit dry weight of the soil when it has been compacted with optimum moisture by the prescribed method of compaction. The

moisture content which gives the highest dry unit weight is called the optimum moisture content for the specific method of compaction.

Mechanical analyses show the percentages, by weight, of soil particles that would pass through sieves of specified sizes. Sand and other coarser materials do not pass through the No. 200 sieve. Silt and clay pass through the No. 200 sieve. Percentage fractions smaller than openings in the No. 200 sieve were determined by the hydrometer method, rather than the pipette method most soil scientists use in determining the clay in soil samples.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a solid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a solid to a plastic state. The liquid limit is the moisture content at which the material changes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

The AASHO and United classifications have been explained earlier in the engineering section.

In table 7, "Engineering test data for soil samples taken along proposed highway routes," the horizon column indicates the major horizons from which the sample was taken. The samples were taken at depths that reflected distinct changes in color and texture and, therefore, may include material from more than one major horizon of the given soil. The column, number of samples tested, shows the total samples tested of major horizons for the series. Table 7 also shows the actual range and average value for each of several soil properties. This range in properties is not necessarily the same as the ranges shown in table 4, "Estimated soil properties significant to engineering."

Formation and Classification of the Soils

This section consists of two main parts. The first part tells how the factors of soil formation have affected the development of soils in Sully County. The second part explains the system of soil classification currently used and places each soil series in some of the classes of that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. These factors act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determine it almost entirely. Finally, time is needed for changing the present material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

In the following paragraphs, the factors of soil formation as they apply to Sully County soils are briefly discussed.

Parent material

Many of the soils in Sully County formed in glacial materials that derived from preglacial formations of granite, gneiss, limestone, sandstone, and shale. The glacier picked up materials weathered from these formations, ground and mixed them as it transported them, and redeposited them as the glacier melted. Some deposits consist of unsorted material, or glacial till; others consist of material sorted either by water as the material was deposited, or by wind and water after it was deposited.

The Glenham-Hoven and the Raber-Glenham soil associations are areas where the soils formed almost entirely in glacial till, but glacial till is also present in other soil associations. The till ranges from loam to clay in texture and from friable to firm in consistence. Among the soils formed in glacial till are those of the Betts, Cavo, Demky, Gettys, Glenham, Java, Oko, Peno, and Raber series.

The dominant soils in the Highmore-Eakin association formed in glacial materials that have been sorted by water or wind. Among the soils that formed in part or entirely in silty glacial drift are those of the DeGrey, Eakin, Highmore, and Walke series. The upper part of the profiles of these soils has relatively few pebbles, cobblestones, and stones, in contrast to those soils that formed in glacial till.

Soils of the Oahe and Talmo series formed in loamy materials over sand and gravel deposited by glacial melt water.

The Pierre Formation is the only bedrock exposed in Sully County. It is a marine shale or claystone of the Cretaceous Age. Among the soils that formed in clayey materials weathered from the Pierre Formation are those of the Dupree, Opal, and Promise series.

Loess mantles the uplands in the western part of the county. Agar, Lowry, and Sully soils formed in these wind-deposited materials.

Onita soils formed in alluvium washed in from adjacent sloping soils. Durrstein and Egas soils formed in alluvium deposited by streams.

Climate

The climate of Sully County is continental and is marked by extreme temperatures. Winters are cold, and summers are hot. The average annual precipitation is about 16 inches, of which about 80 percent is received between mid-April and the end of September. Such a climate is favorable to a grassland ecology. Because the climate is relatively uniform throughout the county, the differences in Sully County soils are not due to climate. Climatic data for the county are given in the section "General Nature of the County."

Plant and animal life

Plants, animals, insects, earthworms, bacteria, and fungi are important in the formation of soils. Among the changes they cause are gains in organic matter, gains or losses in plant nutrients, and changes in structure and porosity.

Soils of Sully County formed under a vegetative cover of grass. This accounts for the moderate to large amounts of organic matter in many of the soils. Bacteria and fungi in the soil help decompose grass residue. Earthworms, cicada, and burrowing animals help keep the soil open and porous.

Relief

Relief, or lay of the land, influences soil formation through its effect on drainage, surface runoff, erosion, plant cover, and soil temperature. Betts, Gettys, and Sully soils are examples of sloping to steep soils that lose much of the rainfall through runoff. This lessens the amount of moisture that enters the soil and contributes to soil loss by erosion. These soils have a thin surface layer and are calcareous at or near the surface. Runoff is slower on the Agar, Glenham, Raber, and similar soils, so that more moisture enters the soil and soil formation is more complete. These soils have thicker horizons containing accumulations of organic matter, and lime is leached to a greater depth. Onita soils are in swales that receive runoff water from adjacent soils. The additional moisture produces more grass and helps to account for the large amount of organic matter in Onita soils. On bottom lands where drainage is impeded and the water table is high, the fluctuating water table favors the concentration of salts in soils such as the Durrstein and Egas soils.

Time

The length of time that soil material has been exposed to the other four factors of soil formation is reflected in the kinds of soil that formed. Most of the soils in Sully County are on relatively young landscapes that date back to the glacial period. The soils that formed in more or less recent loess represent some of the younger soils on uplands. On some of the more stable landscapes are Opal and Promise soils, perhaps the oldest soils in the county.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and used in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Therefore, readers interested in developments of the current system should search the latest literature available (*3*, *5*). In table 8, the soil series of Sully County are placed in some categories of the current system.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. Most of the classes of the current system are briefly defined in the following paragraphs.

ORDER.—Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different kinds of climate. Three soil orders are represented in Sully County: Entisols, Inceptisols, and Mollisols.

Entisols are light-colored soils that do not have natural genetic horizons or that have only very weakly expressed beginnings of such horizons. These soils do not have traits that reflect soil mixing caused by shrinking and swelling.

Inceptisols are light-colored mineral soils that are high in bases and have weakly expressed mineral genetic horizons.

Mollisols formed under grass and have a thick, dark-colored surface layer that contains colloids dominated by bivalent cations. The soil material in these soils has not been mixed by shrinking and swelling.

SUBORDER.—Each order has been subdivided into suborders, primarily on the basis of the characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUPS.—Suborders are separated into great groups on basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that contain a pan

TABLE 8.—*Classification of soil series into higher categories*

Series	Family	Subgroup	Order
Agar	Fine-silty, mixed, mesic	Typic Argiustolls	Mollisols.
Akaska	Fine-silty over sandy or sandy-skeletal, mixed, mesic	Typic Argiustolls	Mollisols.
Betts	Fine-loamy, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Cavo	Fine, mixed, mesic	Typic Natrustolls	Mollisols.
DeGrey	Fine, mixed, mesic	Typic Natrustolls	Mollisols.
Demky	Fine, mixed, mesic	Glossic Natrustolls	Mollisols.
Dupree	Clayey, montmorillonitic, mesic, shallow	Paralithic Vertic Ustochrepts	Inceptisols.
Durrstein	Fine, mixed, mesic	Typic Natraquolls	Mollisols.
Eakin	Fine-silty, mixed, mesic	Typic Argiustolls	Mollisols.
Egas	Fine, mixed (calcareous), mesic	Typic Haplaquolls	Mollisols.
Elpam	Fine-silty, mixed (calcareous), mesic	Typic Haplaquepts	Inceptisols.
Gettys	Fine, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Glenham	Fine-loamy, mixed, mesic	Typic Argiustolls	Mollisols.
Highmore	Fine-silty, mixed, mesic	Typic Argiustolls	Mollisols.
Hoven	Fine, montmorillonitic, mesic	Typic Natraquolls	Mollisols.
Hurley	Very fine, montmorillonitic, mesic	Leptic Natrustolls	Mollisols.
Java	Fine-loamy, mixed, mesic	Typic Haplustolls	Mollisols.
Jerauld	Fine, montmorillonitic, mesic	Leptic Natrustolls	Mollisols.
Lowry	Coarse-silty, mixed, mesic	Typic Haplustolls	Mollisols.
Macken	Fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
Oahe	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Haplustolls	Mollisols.
Oko	Fine, montmorillonitic, mesic	Vertic Argiustolls	Mollisols.
Onita	Fine, mixed, mesic	Pachic Argiustolls	Mollisols.
Opal	Very fine, montmorillonitic, mesic	Vertic Haplustolls	Mollisols.
Peno	Fine, mixed, mesic	Typic Argiustolls	Mollisols.
Promise	Very fine, montmorillonitic, mesic	Vertic Haplustolls	Mollisols.
Raber	Fine, mixed, mesic	Typic Argiustolls	Mollisols.
Ree	Fine-loamy, mixed, mesic	Typic Argiustolls	Mollisols.
Sully	Coarse-silty, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Talmo	Sandy-skeletal, mixed, mesic	Udorthentic Haplustolls	Mollisols.
Walke	Fine, mixed, mesic	Glossic Natrustolls	Mollisols.

that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 8, because it is the last word in the name of the subgroup.

SUBGROUP.—Great groups are divided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the great group.

FAMILY.—Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizon, and consistence.

SERIES.—The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

General Nature of the County

This section discusses development, transportation, markets, recreation, climate, and farming in Sully County.

Sully County was created in 1873 by an act of the Dakota Territory legislature and became an organized county in 1883. It was named for General Alfred Sully. Prior to this a military post, Fort Sully, had been established on Sully Creek in 1866. Clifton and Fairbanks were pioneer towns that disappeared after they were bypassed by the railroad. Onida is the county seat and largest town. Agar and Okobojo are the only other towns and villages.

The county was settled rapidly between the years 1880 and 1900. Like many rural counties, Sully County has had a declining population. The Federal census of 1960 lists a total population of 2,607, of which 60 percent live on farms and ranches.

The county is served by a branch line of the Chicago and North Western Railroad, which passes through the towns of Agar and Onida. U.S. Highway No. 83 crosses through the county from north to south. Hard-surfaced and gravel county roads serve most of the county. A municipal airport is at Onida.

Wheat and other grains are marketed at elevators in Agar and Onida, as well as at Blunt in adjacent Hughes County. Cattle are marketed either through auction barns in the general area or are trucked to Sioux Falls and Sioux City. Sully County has no industrial or processing plants.

Upland game birds and waterfowl provide excellent hunting during the fall months. Lake Oahe provides excellent fishing and has boat landing and picnic areas on its eastern shore in Sully County. Two resorts on the lake provide lodging and equipment for fishermen and hunters.

Of interest to historians and artifact hunters are the sites of Arikara Indian villages in Sully County. Most of the villages were near the Missouri River and many of them are now inundated. The villages date back prior to 1800, at about which time the Arikara Indians were driven out by the more aggressive Sioux.

Climate [9]

Sully County has a continental-type climate that is characterized by usually cold winters and hot summers and by little precipitation in winter and marginal rainfall during the growing season. The recently formed Lake Oahe extends along the western border of Sully County. It may have some effect on the climate in its immediate vicinity, but elsewhere over the county the climate is not affected by large bodies of water or other physical features.

Table 9 lists temperature and precipitation data that are representative for Sully County. Table 10 gives probability of specified damaging temperatures after specified dates in spring and before specified dates in fall.

The climatic summary for this county is based on 45 years (1921–1965) of weather observations taken at Onida, which is located near the center of the county at an elevation of 1,865 feet. Climate at Onida is representative for that throughout the county. The average annual precipitation may vary as much as one-half inch from north to south and as much as 1 inch from west to east. The mean annual temperature throughout the county is expected to be within 1 degree of that at Onida.

The temperature has a large seasonal variation and occasionally a large difference from day to day. Readings have gone above 100°F. in summer and dropped to lower than −30° in winter. Temperatures on the average are expected to climb to 100° or more about once a year in June, 3 times per year in July and August, and once in 2 years in September. The temperature may drop to −30° or lower on the average about once in 4 years and to −20° or lower on the average about twice a year in January, once a year in February, and once in 2 years in December. Minimum temperatures of zero or lower can be expected on the average about 30 times per year. Temperatures may fail to climb above zero during the day on the average about 4 times per year.

Table 10 shows the chance of certain low temperatures occurring after specified dates in spring or before indicated dates in fall. For example, the upper half of the table shows a 50 percent chance that a temperature of 32 degrees or lower will occur on or after May 14. It means that in about 5 years out of 10, a temperature of 32 degrees or lower may be expected at Onida on May 14 or later. The 50 percent chance date is also the average date of the indicated temperature.

[9] By WALTER SPUHLER, State climatologist, National Weather Service, U.S. Department of Commerce.

TABLE 9.—*Temperature and precipitation*

[Data obtained from records at Onida for the period 1921–63. Table prepared on electronic computer by W. F. Lytle, Dept. of Agricultural Engineering, South Dakota State University, Brookings, South Dakota]

Month	Temperature				Precipitation						Average number of days with—	
			Two years in 10 will have—					One year in 10 will have—				
	Average daily maximum	Average daily minimum	Monthly average of the daily maximum equal to or higher than—	Monthly average of the daily minimum equal to or lower than—	Average total	Maximum total	Minimum total	Less than—	More than—	Average total snowfall	Snowfall of 1 inch or more	Depth of snow cover 1 inch or more [1]
	°F.	°F.	°F.	°F.	In.	In.	In.	In.	In.	In.		
January	25. 1	3. 6	36. 0	−4. 3	0. 29	1. 07	0	0. 03	0. 70	3	1	14
February	30. 2	8. 1	41. 4	−0. 6	. 43	1. 89	0	. 05	1. 00	4	1	14
March	41. 0	18. 9	49. 6	12. 4	. 77	2. 40	0	. 31	1. 58	5	2	9
April	58. 7	32. 8	65. 0	28. 4	1. 64	5. 16	0	. 38	3. 37	2	0	1
May	70. 6	43. 7	77. 2	39. 3	2. 62	7. 07	. 10	. 82	4. 81	0	0	0
June	79. 8	53. 6	86. 3	50. 0	3. 30	7. 12	. 18	1. 01	6. 20	0	0	0
July	89. 2	59. 9	95. 1	56. 1	1. 84	5. 49	. 36	. 65	3. 36	0	0	0
August	87. 9	57. 8	93. 1	54. 5	2. 13	7. 04	. 27	. 51	4. 21	0	0	0
September	76. 5	47. 0	82. 4	43. 0	1. 19	5. 05	0	. 23	2. 54	0	0	0
October	63. 8	35. 7	70. 3	31. 2	1. 08	3. 82	0	. 10	2. 53	1	0	0
November	43. 8	21. 5	50. 8	16. 3	. 35	1. 67	0	. 09	. 77	2	0	3
December	30. 4	9. 9	38. 7	2. 8	. 28	2. 29	0	. 03	. 75	3	1	10
Year	58. 1	32. 7	60. 4	30. 7	15. 92	[2] 24. 67	[3] 10. 59	11. 66	19. 73	20	5	51

[1] Values adjusted to agree with Pierre reports because snow cover reports at Onida were not always reliable.
[2] 1962.
[3] 1931.

TABLE 10.—*Probabilities of specified damaging temperatures after specified dates in spring and before specified dates in fall*

[Data obtained from records at Onida for the period 1921–65 by William F. Lytle, South Dakota State University, using punch cards and electronic computer]

Probability	Dates for given probability and temperature					
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower	36° F. or lower
After specified dates in spring:						
90 percent	March 16	March 18	March 29	April 9	April 23	May 4
70 percent	March 22	March 27	April 6	April 17	April 30	May 11
50 percent	April 2	April 13	April 23	May 3	May 14	May 24
30 percent	April 12	April 29	May 8	May 17	May 27	June 6
10 percent	April 18	May 8	May 17	May 26	June 3	June 13
Before specified dates in fall:						
10 percent	October 8	October 1	September 24	September 16	September 7	August 25
30 percent	October 16	October 10	October 2	September 22	September 14	September 1
50 percent	November 1	October 27	October 18	October 4	September 27	September 15
70 percent	November 16	November 13	November 2	October 15	October 9	September 27
90 percent	November 25	November 22	November 10	October 22	October 16	October 4

Similarly, the lower half of table 10 shows there is a 30 percent chance that a temperature of 32 degrees or lower will occur by September 14. This should be interpreted that on the average, 3 years out of 10 the temperature will be 32 degrees or lower at Onida on or before this date. These figures refer to air temperatures as measured in a standard instrument shelter. Soil and plant temperatures vary somewhat from the temperature of the free air.

The average annual precipitation at Onida is 15.92 inches, of which 12.72 inches, or 80 percent, falls during the growing season (April to September). During the 45-year period of record, the annual precipitation ranged from 10.59 inches in 1931 to 24.67 inches in 1962. Thundershowers are the main source of rainfall during the growing season, and they produce a wide range of rainfall intensity and amount. A rainfall of 1 inch or more in 1 hour can be expected about once each year. Two inches or more of rain in 1 hour can be expected about once in 7 years. A 24-hour rainfall of 2 inches or more can be expected about once in 4 years, and about once in 11 years a 24-hour rainfall of 3 inches or more can be expected.

A snow cover is important for protecting pastures and fall-seeded grains, but it can be a hindrance to farm or ranch activities in winter. The seasonal snowfall at Onida averages 20 inches and has ranged from 4.1 inches during the 1945–46 season to 48.5 inches during the 1947–48 season.

Sunshine, wind, and relative humidity are not observed at Onida. Data from other stations in the same vicinity, however, can be used to estimate conditions in Sully County. The sun shines on the average about 63 percent of the total possible time during the year. The relative humidity usually has a large variation from early morning to afternoon and occasionally from day to day. The annual average is about 80 percent in the early morning and about 50 percent during afternoon. Windspeed averages about 11 m.p.h., with prevailing winds generally from the south in summer and from the northwest in winter. A wind speed of 50 m.p.h. or more may occur during any month, but is most likely to occur in summer in association with thunderstorms.

Thunderstorms occur on the average of about 7 days per month in May, 11 in June and July, and 9 in August. They are fewer in other months, and an annual average is about 44. Hail occasionally accompanies the thunderstorms and may be expected at any one location in the county about once in 2 years. Hail has been reported as early as April and as late as September but the months of most frequent occurrence are July and August.

The potential water loss from soil and crops is indicated by the loss from an evaporation pan. The average annual evaporation from the Weather Service Class A pan in this county is about 50 inches. An average of about 40 inches evaporates from May through October. The evaporation from small lakes is about 36 inches, and the loss of water from the soil and crops is usually less, depending on the available moisture in the soil.

Farming

Most of the early settlers of Sully County were homesteaders who came from the more humid parts of the country. They brought with them the farming methods with which they were familiar. The average size farm in 1890 was 254 acres. Small diversified farms were the main enterprise. Livestock farming and wheat farming are now the main agricultural enterprises. Livestock ranches are dominant in the western part of the county near Lake Oahe. The average size of farm in 1964 was 1,830 acres. Only about 16 percent of the farms and ranches are operated by tenants.

The major crops in this county are wheat, corn, oats, and alfalfa. Other crops grown are barley, rye, flax, and sorghum. In 1968 (*4*) there were 116,000 acres in wheat, of which 48,000 acres were winter wheat; 49,000 acres in corn; and 42,500 acres in oats. Alfalfa was harvested from 15,500 acres. The trend has been an increasing acreage of winter wheat grown on fallow with decreasing acreages in spring wheat and corn. Also, there has been a gradual increase in the acreage of oats.

On January 1, 1969 (*4*), there were 52,000 cattle on farms and ranches, but only 600 were cows and heifers kept mainly for milk production. Also on farms and ranches were 17,900 hogs, 17,100 sheep, and 10,000 chickens. The number of cattle has gradually increased since 1940, when there were only 16,400 cattle on Sully County farms and ranches following the drought years.

Information about the past history of crops and crop production and about numbers of livestock in the county can be obtained from the annual reports of the South Dakota Crop and Livestock Reporting Service.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. In this survey the classes of available water capacity for a 60-inch profile are as follows: Very low, 0 to 3; low, 3 to 6; moderate, 6 to 9; and high, 9 to 12.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizons above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Conservation cropping system. Growing crops in combination with needed cultural and management measures. Cropping systems include rotations that contain grasses and legumes as well as rotations in which the desired benefits are achieved without the use of such crops.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Contour stripcropping. Growing crops in strips that follow the contour or are parallel to terraces or diversions. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Crop residue management. A system of retaining crop residue on land between harvest and replanting to prevent erosion and insure future crop production.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Emergency tillage. Cultivation by listing, ridging, duckfooting, chiseling, pitting basin listing, or other means to roughen the soil surface for temporary control of wind erosion.

Field windbreak. A strip or belt of trees or shrubs established within or adjacent to a field.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of silt, sand, and boulders transported and deposited by glacial ice.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, and covered by grass for protection against erosion; used to conduct surface water away from cropland.

Gravelly soil material. From 15 to 50 percent of material, by volume, consists of rounded or angular rock fragments that are not prominently flattened and are up to 3 inches in diameter.

Green manure crop (agronomy). A crop grown for the purpose of being turned under in an early stage of maturity or soon after maturity for soil improvement.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Minimum tillage. The least amount of tillage required for quick germination and a good stand. Several implements may be drawn behind the tractor to reduce the number of times it is driven over the field, but it does not imply that primary tillage, secondary tillage, fertilization, and seeding must be done in one trip across the field.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Runoff (hydraulics). The part of precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Segregations. Masses in a profile that are distinctly separate from the rest of the soil material. An example is segregated lime.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Stubble mulch. Stubble or other crop residues left on the soil, or partly worked into the soil, to provide protection from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Wind stripcropping. Growing crops in strips that run crosswise to the general direction of prevailing wind and without strict adherence to the contour of the land.

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GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit, a pasture group, a range site, or a windbreak suitability group, read the introduction to the section it is in for general information about its management. For facts about wildlife and recreation, turn to the section beginning on p. 53. Other information is given in tables as follows:

Acreage and extent, table 1, page 9.
Predicted yields, table 2, page 46.

Engineering uses of the soils, tables 4, 5, 6, and 7, pages 54 through 75.

Map symbol	Mapping unit	Page	Capability unit		Pasture group	Range site	Windbreak group
			Symbol	Page	Symbol	Name	Number
AaA	Agar silt loam, 0 to 2 percent slopes	10	IIc-2	41	F	Silty	3
AaB	Agar silt loam, 2 to 5 percent slopes	10	IIe-1	40	F	Silty	3
AaC	Agar silt loam, 5 to 9 percent slopes	11	IIIe-1	42	F	Silty	3
AdA	Agar-DeGrey silt loams, 0 to 2 percent slopes	11	IVs-2	43	------	----------	------
	Agar soil	--	------	--	F	Silty	3
	DeGrey soil	--	------	--	C	Claypan	9
AeA	Agar-Eakin silt loams, 0 to 2 percent slopes	11	IIc-2	41	F	Silty	3
AeB	Agar-Eakin silt loams, 2 to 5 percent slopes	11	IIe-1	40	F	Silty	3
AeC	Agar-Eakin silt loams, 5 to 9 percent slopes	11	IIIe-1	42	F	Silty	3
AgA	Agar-Onita silt loams, 0 to 1 percent slopes	11	IIc-2	41	------	----------	------
	Agar soil	--	------	--	F	Silty	3
	Onita soil	--	------	--	K	Overflow	1
AkA	Agar-Walke silt loams, 0 to 2 percent slopes	12	IIc-2	41	------	----------	------
	Agar soil	--	------	--	F	Silty	3
	Walke soil	--	------	--	E	Clayey	4
AlA	Akaska silt loam, 0 to 2 percent slopes	12	IIIs-2	42	D	Silty	6
AlB	Akaska silt loam, 2 to 5 percent slopes	13	IIIe-6	42	D	Silty	6
BeE	Betts loam, 6 to 25 percent slopes	13	VIe-3	44	G	Thin Upland	10
Cd	Clayey alluvial land	14	VIw-1	44	------	Overflow	10
DoF	Dupree-Opal clays, 6 to 34 percent slopes	16	VIIs-2	45	------	----------	10
	Dupree soil	--	------	--	------	Dense Clay	------
	Opal soil	--	------	--	------	Clayey	------
Ds	Dupree-Shale outcrop complex	16	------	--	------	----------	------
	Dupree soil	--	VIIs-2	45	------	Dense Clay	10
	Shale outcrop	--	VIIIs-2	45	------	----------	------
Du	Durrstein and Egas soils	17	-------	--	------	----------	10
	Durrstein soil	--	VIw-4	44	J	Saline Lowland	------
	Egas soil	--	VIIs-5	45	------	Saline Lowland	------
Eg	Egas silty clay	18	VIIs-5	45	------	Saline Lowland	10
Ep	Elpam silt loam	18	IVw-1	43	J	Subirrigated	10
GeE	Gettys clay loam, 6 to 25 percent slopes	19	VIe-3	44	G	Thin Upland	10
GlA	Glenham loam, 0 to 3 percent slopes	20	IIc-2	41	F	Silty	3
GlB	Glenham loam, 3 to 6 percent slopes	21	IIe-2	41	F	Silty	3
GlC	Glenham loam, 6 to 9 percent slopes	21	IIIe-2	42	F	Silty	3
HcA	Highmore silt loam, 0 to 2 percent slopes	22	IIc-2	41	F	Silty	3
HdA	Highmore-DeGrey silt loams, 0 to 2 percent slopes	22	IVs-2	43	------	----------	------
	Highmore soil	--	------	--	F	Silty	3
	DeGrey soil	--	------	--	C	Claypan	9
HeA	Highmore-Eakin silt loams, 0 to 2 percent slopes	22	IIc-2	41	F	Silty	3
HeB	Highmore-Eakin silt loams, 2 to 5 percent slopes	22	IIe-1	40	F	Silty	3
HmA	Highmore-Walke silt loams, 0 to 2 percent slopes	22	IIc-2	41	------	----------	------
	Highmore soil	--	------	--	F	Silty	3
	Walke soil	--	------	--	E	Clayey	4
Ho	Hoven silt loam	23	VIs-1	44	B	Closed Depression	10
HuA	Hurley silt loam, 0 to 5 percent slopes	24	VIs-1	44	------	Thin Claypan	10
JbD	Java-Betts loams, 6 to 15 percent slopes	25	VIe-3	44	------	----------	------
	Java soil	--	------	--	F	Silty	3
	Betts soil	--	------	--	G	Thin Upland	10
JcD	Java-Betts stony complex, 3 to 12 percent slopes	25	VIIs-6	47	------	----------	------
	Java soil	--	------	--	------	Silty	3
	Betts soil	--	------	--	------	Thin Upland	10
JgC	Java-Glenham loams, 3 to 9 percent slopes	25	IVe-3	43	F	Silty	3
JkA	Jerauld-Demky loams, 0 to 1 percent slopes	26	VIs-1	44	------	----------	------
	Jerauld soil	--	------	--	------	Thin Claypan	10
	Demky soil	--	------	--	E	Clayey	4
LoA	Lowry silt loam, 0 to 2 percent slopes	26	IIe-1	40	F	Silty	3
LoB	Lowry silt loam, 2 to 5 percent slopes	26	IIe-1	40	F	Silty	3
LoC	Lowry silt loam, 5 to 9 percent slopes	27	IIIe-1	42	F	Silty	3
LoD	Lowry silt loam, 9 to 12 percent slopes	27	IVe-1	43	F	Silty	3

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Pasture group	Range site	Windbreak group
			Symbol	Page	Symbol	Name	Number
Ma	Macken silty clay loam	27	VIs-1	44	B	Closed Depression	10
OaA	Oahe loam, 0 to 2 percent slopes	28	IIIs-2	42	D	Silty	6
OaB	Oahe loam, 2 to 6 percent slopes	28	IIIe-6	42	D	Silty	6
OhA	Oahe-Talmo loams, 0 to 2 percent slopes	28	IIIs-2	42	------	----------	------
	Oahe soil	--	------	--	D	Silty	6
	Talmo soil	--	------	--	------	Very Shallow	10
OhB	Oahe-Talmo loams, 2 to 6 percent slopes	28	VIs-4	44	------	----------	------
	Oahe soil	--	------	--	D	Silty	6
	Talmo soil	--	------	--	------	Very Shallow	10
OkA	Oko clay loam, 0 to 3 percent slopes	29	IIIs-3	43	I	Clayey	4
OkB	Oko clay loam, 3 to 6 percent slopes	29	IIIe-4	42	I	Clayey	4
OkC	Oko clay loam, 6 to 9 percent slopes	29	IVe-4	43	I	Clayey	4
OlE	Oko stony clay loam, 6 to 25 percent slopes	30	VIIs-6	45	------	Clayey	10
OnA	Onita silt loam, 0 to 2 percent slopes	30	IIc-3	41	K	Overflow	1
OnB	Onita silt loam, 2 to 5 percent slopes	30	IIe-3	40	K	Silty	1
OrA	Onita-DeGrey silt loams, 0 to 2 percent slopes	30	IIc-3	41	------	----------	------
	Onita soil	--	------	--	K	Overflow	1
	DeGrey soil	--	------	--	C	Claypan	9
OsA	Onita-Hoven silt loams, 0 to 1 percent slopes	31	IIc-3	41	------	----------	------
	Onita soil	--	------	--	K	Overflow	1
	Hoven soil	--	------	--	B	Closed Depression	10
OtB	Opal clay, 2 to 6 percent slopes	31	IIIe-4	42	I	Clayey	4
OtC	Opal clay, 6 to 9 percent slopes	31	IVe-4	43	I	Clayey	4
OuD	Opal-Dupree clays, 6 to 21 percent slopes	32	VIe-4	44	------	----------	10
	Opal soil	--	------	--	------	Clayey	------
	Dupree soil	--	------	--	------	Dense Clay	------
PrA	Promise silty clay, 0 to 2 percent slopes	33	IIIs-3	43	I	Clayey	4
PrB	Promise silty clay, 2 to 5 percent slopes	33	IIIe-4	42	I	Clayey	4
RcA	Raber-Cavo loams, 0 to 2 percent slopes	34	IVs-2	43	------	----------	------
	Raber soil	--	------	--	F	Clayey	3
	Cavo soil	--	------	--	C	Claypan	9
RcB	Raber-Cavo loams, 2 to 5 percent slopes	34	IVs-3	44	------	----------	------
	Raber soil	--	------	--	F	Clayey	3
	Cavo soil	--	------	--	C	Claypan	9
RdA	Raber-Demky loams, 0 to 2 percent slopes	34	IIc-2	41	------	----------	------
	Raber soil	--	------	--	F	Clayey	3
	Demky soil	--	------	--	E	Clayey	4
RdB	Raber-Demky loams, 2 to 5 percent slopes	34	IIe-2	40	------	----------	------
	Raber soil	--	------	--	F	Clayey	3
	Demky soil	--	------	--	E	Clayey	4
RgB	Raber and Glenham loams, 3 to 6 percent slopes	34	IIe-2	40	F	----------	3
	Raber soil	--	------	--	------	Clayey	------
	Glenham soil	--	------	--	------	Silty	------
RgC	Raber and Glenham loams, 6 to 9 percent slopes	34	IIIe-2	42	------	----------	3
	Raber soil	--	------	--	------	Clayey	------
	Glenham soil	--	------	--	------	Silty	------
RhA	Raber-Highmore silt loams, 0 to 3 percent slopes	35	IIc-2	41	F	----------	3
	Raber soil	--	------	--	------	Clayey	------
	Highmore soil	--	------	--	------	Silty	------
RhC	Raber-Highmore silt loams, 5 to 9 percent slopes	35	IIIe-2	42	F	----------	3
	Raber soil	--	------	--	------	Clayey	------
	Highmore soil	--	------	--	------	Silty	------
RpB	Raber-Peno loams, 3 to 6 percent slopes	35	IIe-2	40	F	Clayey	3
RpC	Raber-Peno loams, 6 to 9 percent slopes	35	IIIe-2	42	F	Clayey	3
RrA	Ree loam, 0 to 2 percent slopes	36	IIc-2	41	F	Silty	3
RrB	Ree loam, 2 to 5 percent slopes	36	IIe-1	40	F	Silty	3
Rt	Ree and Durrstein soils	36	------	--	------	----------	------
	Ree soil	--	IIc-2	41	F	Silty	3
	Durrstein soil	--	VIw-4	43	J	Saline Lowland	10
Ru	Rough broken land	36	VIIs-6	45	------	----------	------
Sa	Saline and alkali land	36	VIIs-5	45	------	Saline Lowland	10
St	Shale land	37	VIIIs-2	45	------	----------	------
SuE	Sully silt loam, 12 to 25 percent slopes	37	VIe-3	44	------	Thin Upland	10
SwD	Sully-Lowry silt loams, 3 to 12 percent slopes	37	IVe-3	43	------	----------	------
	Sully soil	--	------	--	G	Thin Upland	10
	Lowry soil	--	------	--	F	Silty	3
TaE	Talmo gravelly loam, 9 to 25 percent slopes	38	VIIs-4	45	------	Very Shallow	10

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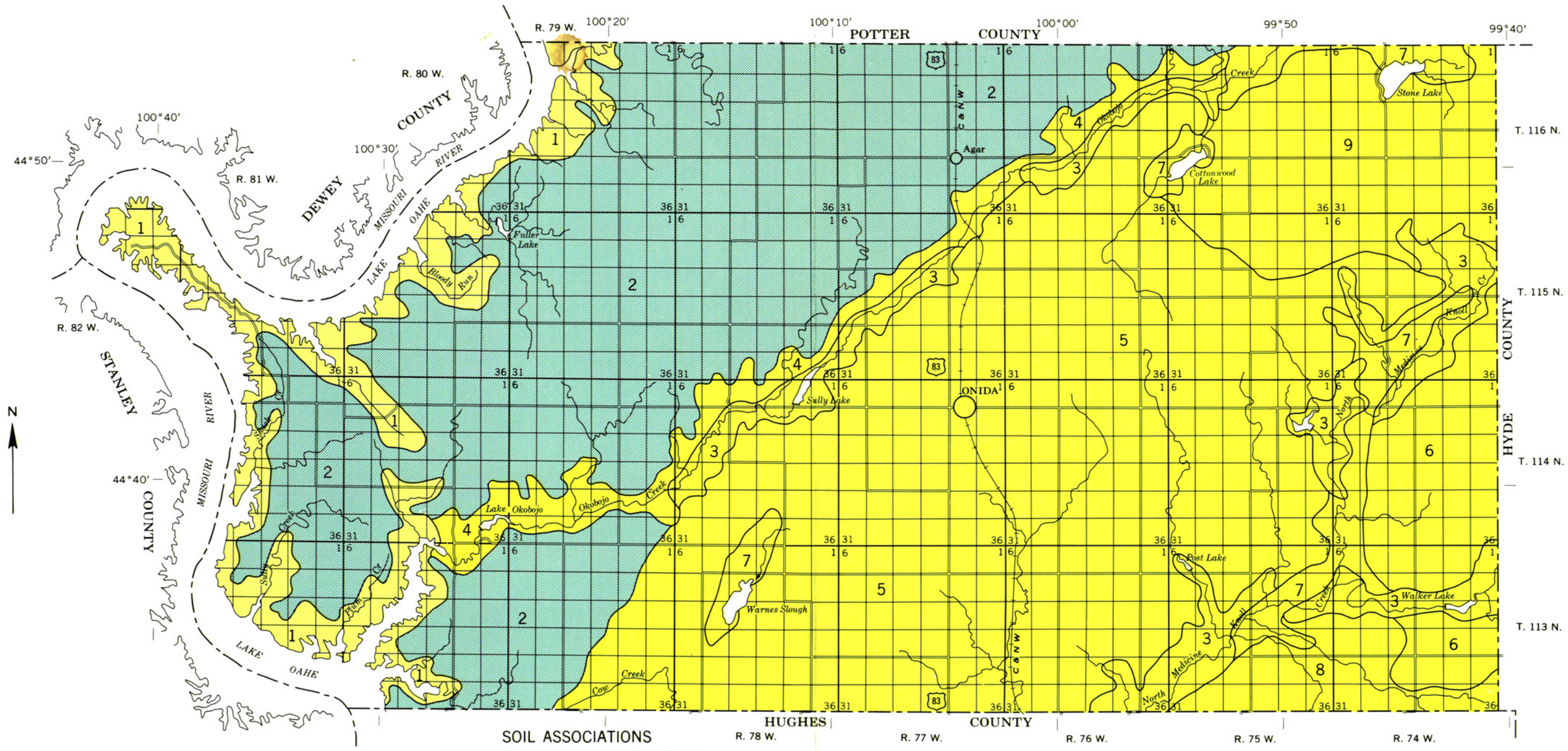


SOIL ASSOCIATIONS

CLAYEY SOILS ON MISSOURI RIVER BREAKS

1 — Dupree association: Shallow, sloping to steep, well-drained, clayey soils over shale; on uplands

SILTY SOILS ON LOESS-COVERED UPLANDS

2 — Agar-Onita association: Deep, nearly level to sloping, well-drained, silty soils formed in loess and deep, moderately well drained, silty soils formed in alluvium; on uplands

SILTY AND LOAMY SOILS FORMED IN GLACIAL DRIFT, GLACIAL TILL, AND GLACIAL OUT-WASH MATERIALS, MAINLY ON UPLANDS AND TERRACES

3 — Betts-Durrstein association: Deep, undulating to hilly, excessively drained, loamy soils formed in glacial till and deep, level, poorly drained claypan soils formed in alluvium; on uplands and bottom lands

4 — Oko association: Deep, nearly level to hilly, well-drained, loamy soils formed in glacial till; on uplands

5 — Highmore-Eakin association: Deep, nearly level to undulating, well-drained, silty soils formed in silty drift and loamy glacial till; on uplands

6 — Glenham-Hoven association: Deep, nearly level to gently undulating, well-drained, loamy soils formed in glacial till and deep, level, claypan soils formed in alluvium in depressions; on uplands

7 — Oahe-Talmo association: Nearly level to hilly, well-drained to excessively drained, loamy soils formed in alluvium over sand and gravel; on terraces and uplands

8 — Highmore-Raber-Cavo association: Deep, nearly level to gently sloping, well drained and moderately well drained, silty and loamy soils formed in silty drift and glacial till; on uplands

9 — Raber-Glenham association: Deep, nearly level to undulating, well-drained, loamy soils formed in glacial till; on uplands

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

SULLY COUNTY, SOUTH DAKOTA

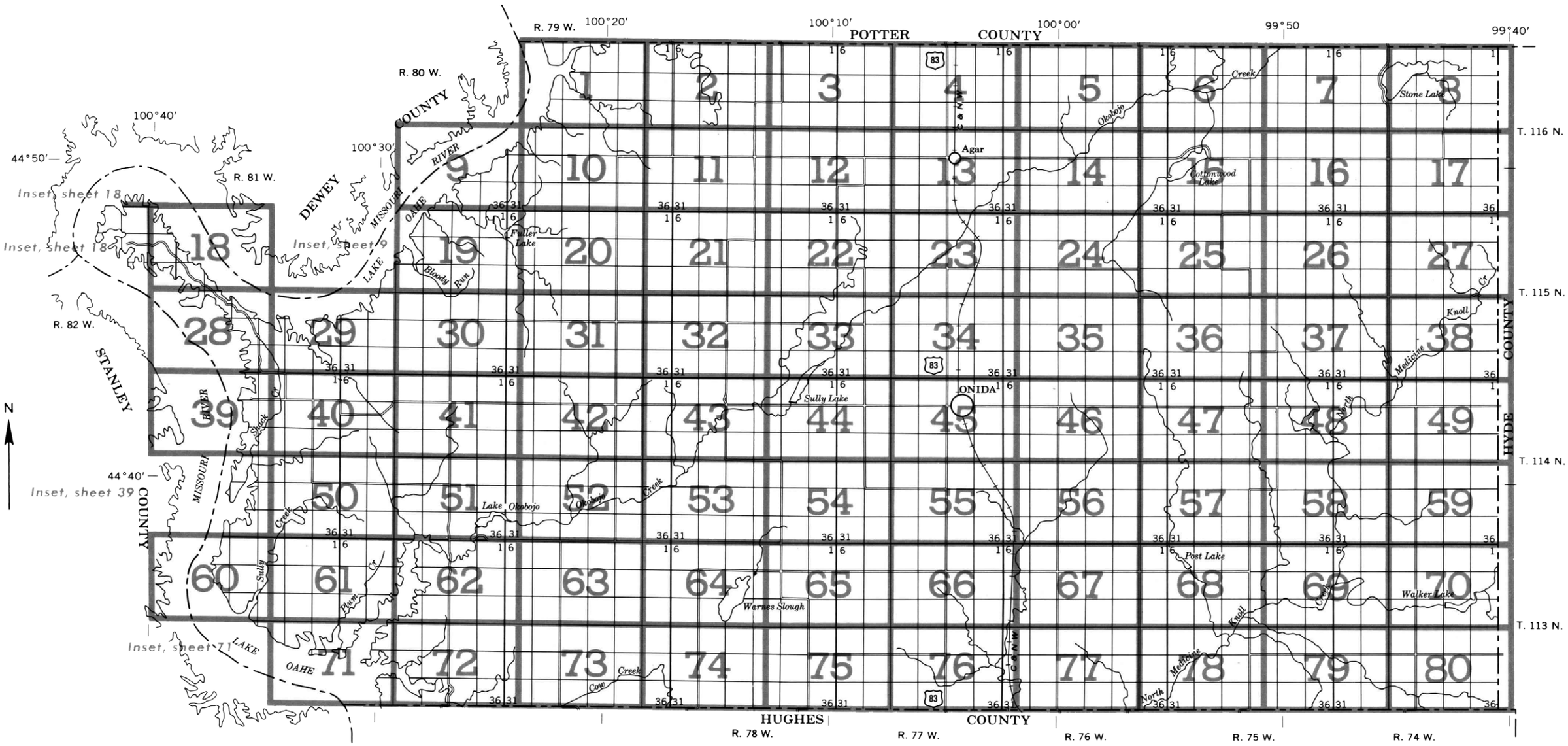
Scale 1:253,440

1 0 1 2 3 4 Miles

Compiled 1972

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36



Original text from each individual map sheet read:

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the South Dakota Agricultural Experiment Station. Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the South Dakota coordinate system, North Zone. Land division corners are approximately positioned on this map.

INDEX TO MAP SHEETS

SULLY COUNTY, SOUTH DAKOTA

Scale 1:253,440

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SULLY COUNTY, SOUTH DAKOTA

SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, E, or F shows the slope. Most symbols without a slope letter are those of nearly level soils, but some are for land types that have a considerable range of slope.

SYMBOL	NAME
AgA	Agar silt loam, 0 to 2 percent slopes
AgB	Agar silt loam, 2 to 5 percent slopes
AgC	Agar silt loam, 5 to 9 percent slopes
AdA	Agar-DeGrey silt loams, 0 to 2 percent slopes
AeA	Agar-Eakin silt loams, 0 to 2 percent slopes
AeB	Agar-Eakin silt loams, 2 to 5 percent slopes
AeC	Agar-Eakin silt loams, 5 to 9 percent slopes
AgA	Agar-Onita silt loams, 0 to 1 percent slopes
AkA	Agar-Walke silt loams, 0 to 2 percent slopes
AlA	Akaska silt loam, 0 to 2 percent slopes
AlB	Akaska silt loam, 2 to 5 percent slopes
BeE	Betts loam, 6 to 25 percent slopes
Cd	Clayey alluvial land
DoF	Dupree-Opal clays, 6 to 34 percent slopes
Ds	Dupree-Shale outcrop complex
Du	Durrstein and Egas soils
Eg	Egas silty clay
Ep	Elpam silt loam
GeE	Gettys clay loam, 6 to 25 percent slopes
GlA	Glenham loam, 0 to 3 percent slopes
GlB	Glenham loam, 3 to 6 percent slopes
GlC	Glenham loam, 6 to 9 percent slopes
HcA	Highmore silt loam, 0 to 2 percent slopes
HdA	Highmore-DeGrey silt loams, 0 to 2 percent slopes
HeA	Highmore-Eakin silt loams, 0 to 2 percent slopes
HeB	Highmore-Eakin silt loams, 2 to 5 percent slopes
HmA	Highmore-Walke silt loams, 0 to 2 percent slopes
Ho	Hoven silt loam
HuA	Hurley silt loam, 0 to 5 percent slopes
JbD	Java-Betts loams, 6 to 15 percent slopes
JcD	Java-Betts stony complex, 3 to 12 percent slopes
JgC	Java-Glenham loams, 3 to 9 percent slopes
JkA	Jerauld-Demky loams, 0 to 1 percent slopes
LoA	Lowry silt loam, 0 to 2 percent slopes
LoB	Lowry silt loam, 2 to 5 percent slopes
LoC	Lowry silt loam, 5 to 9 percent slopes
LoD	Lowry silt loam, 9 to 12 percent slopes
Ma	Macken silty clay loam
OaA	Oahe loam, 0 to 2 percent slopes
OaB	Oahe loam, 2 to 6 percent slopes
OhA	Oahe-Talmo loams, 0 to 2 percent slopes
OhB	Oahe-Talmo loams, 2 to 6 percent slopes
OkA	Oko clay loam, 0 to 3 percent slopes
OkB	Oko clay loam, 3 to 6 percent slopes
OkC	Oko clay loam, 6 to 9 percent slopes
OlE	Oko stony clay loam, 6 to 25 percent slopes
OnA	Onita silt loam, 0 to 2 percent slopes
OnB	Onita silt loam, 2 to 5 percent slopes
OrA	Onita-DeGrey silt loams, 0 to 2 percent slopes
OsA	Onita-Hoven silt loams, 0 to 1 percent slopes
OtB	Opal clay, 2 to 6 percent slopes
OtC	Opal clay, 6 to 9 percent slopes
OuD	Opal-Dupree clays, 6 to 21 percent slopes
PrA	Promise silty clay, 0 to 2 percent slopes
PrB	Promise silty clay, 2 to 5 percent slopes
RcA	Raber-Cavo loams, 0 to 2 percent slopes
RcB	Raber-Cavo loams, 2 to 5 percent slopes
RdA	Raber-Demky loams, 0 to 2 percent slopes
RdB	Raber-Demky loams, 2 to 5 percent slopes
RgB	Raber and Glenham loams, 3 to 6 percent slopes
RgC	Raber and Glenham loams, 6 to 9 percent slopes
RhA	Raber-Highmore silt loams, 0 to 3 percent slopes
RhC	Raber-Highmore silt loams, 5 to 9 percent slopes
RpB	Raber-Peno loams, 3 to 6 percent slopes
RpC	Raber-Peno loams, 6 to 9 percent slopes
RrA	Ree loam, 0 to 2 percent slopes
RrB	Ree loam, 2 to 5 percent slopes
Rt	Ree and Durrstein soils
Ru	Rough broken land
Sa	Saline and alkali land
St	Shale land
SuE	Sully silt loam, 12 to 25 percent slopes
SwD	Sully-Lowry silt loams, 3 to 12 percent slopes
TaE	Talmo gravelly loam, 9 to 25 percent slopes

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements

Top of flood control level

Canals and ditches

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Artesian overflow

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness
  - Stony
  - Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully

SULLY COUNTY, SOUTH DAKOTA — SHEET NUMBER 1

1 900 000 FEET

R. 79 W.

POTTER COUNTY

385 000 FEET

LAKE OAHE

DEWEY COUNTY

Artichoke Creek

Troy Lake

Artichoke Butte

(Joins sheet 2)

(Joins sheet 10)

T. 116 N.

375 000 FEET

1 920 000 FEET

N.

1 Mile

5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

SULLY COUNTY, SOUTH DAKOTA — SHEET NUMBER 2

(2)

N

R. 79 W. | R. 78 W.

POTTER COUNTY

1 940 000 FEET

385 000 FEET

T. 116 N.

(Joins sheet 3)

1 Mile

5 000 Feet

Scale 1:20 000

(Joins sheet 1)

375 000 FEET

(Joins sheet 11)

1 925 000 FEET

intermittent

1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 17 18

SULLY COUNTY, SOUTH DAKOTA — SHEET NUMBER 3

1 945 000 FEET

R. 78 W. | R. 77 W.

POTTER COUNTY

3

N

385 000 FEET

T. 116 N.

(Joins sheet 2)

(Joins sheet 4)

375 000 FEET

(Joins sheet 12)

1 965 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

1 5 000 ¾ 4 000 ½ 3 000 ¼ 2 000 0 1 000 0

N

POTTER COUNTY

R. 77 W. | R. 76 W.

1 990 000 FEET

385 000 FEET

T. 116 N.

1 Mile

5 000 Feet

Scale 1:20 000

1 000 Feet

2 000

3 000

4 000

375 000 FEET

5 000

1 970 000 FEET

(Joins sheet 3)

(Joins sheet 5)

(Joins sheet 13)

WESTERN

NORTH

AND

CHICAGO

Mundt Lake

1 995 000 FEET

R. 76 W.

POTTER COUNTY

385 000 FEET

T. 116 N.

(Joins sheet 4)

(Joins sheet 6)

(Joins sheet 14)

375 000 FEET

2 015 000 FEET

Mundt Lake

Okobojo Creek

5

N

1 Mile

5 000 Feet

Scale 1:20 000

(6)

N

R. 76 W. | R. 75 W.

POTTER COUNTY

2 035 000 FEET

T. 116 N.

385 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

(Joins sheet 5)

(Joins sheet 7)

375 000 FEET

(Joins sheet 15)

2 020 000 FEET

Okobojo Creek

N

2 040 000 FEET

R. 75 W. | R. 74 W.

POTTER COUNTY

385 000 FEET

T. 116 N.

STONE LAKE

intermittent

(Joins sheet 8)

(Joins sheet 6)

(Joins sheet 16)

2 060 000 FEET

375 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

(8)

N

R. 74 W.

POTTER COUNTY

2 085 000 FEET

HYDE COUNTY

385 000 FEET

T. 116 N.

1 Mile

5 000 Feet

Scale 1:20 000 (Joins sheet 7)

STONE LAKE

intermittent

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

375 000 FEET

2 065 000 FEET (Joins sheet 17)

N

1 875 000 FEET

370 000 FEET

1 870 000 FEET

345 000 FEET

340 000 FEET

LAKE OAHE

DEWEY COUNTY

T. 115 N.

T. 116 N.

(Joins sheet 19)

(Joins sheet 10)

(Joins sheet 29)

(Joins sheet 19)

R. 80 W.

R. 79 W.

1 873 000 FEET

1 895 000 FEET

360 000 FEET

3 000 AND 5 000-FOOT GRID TICKS

1 Mile

5 000 Feet

Scale 1:20 000

0 1/4 1/2 3/4 1

0 1 000 2 000 3 000 4 000 5 000

17 19 25 26 30 31 34 35 36

Ds DoF TaE Ru LoC LoD SuE SwD LoB AaC AaB AaA AeC GeE AkA OsA Ho OnA

(10)

N

R. 79 W.

(Joins sheet 1)

1 920 000 FEET

370 000 FEET

T. 116 N.

(Joins sheet 9)

(Joins sheet 11)

1 900 000 FEET

(Joins sheet 20)

LAKE OAHE

Artichoke Butte

19 20 21 22 23 24

30 29 28 27 26 25

31 32 33 34 35 36

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

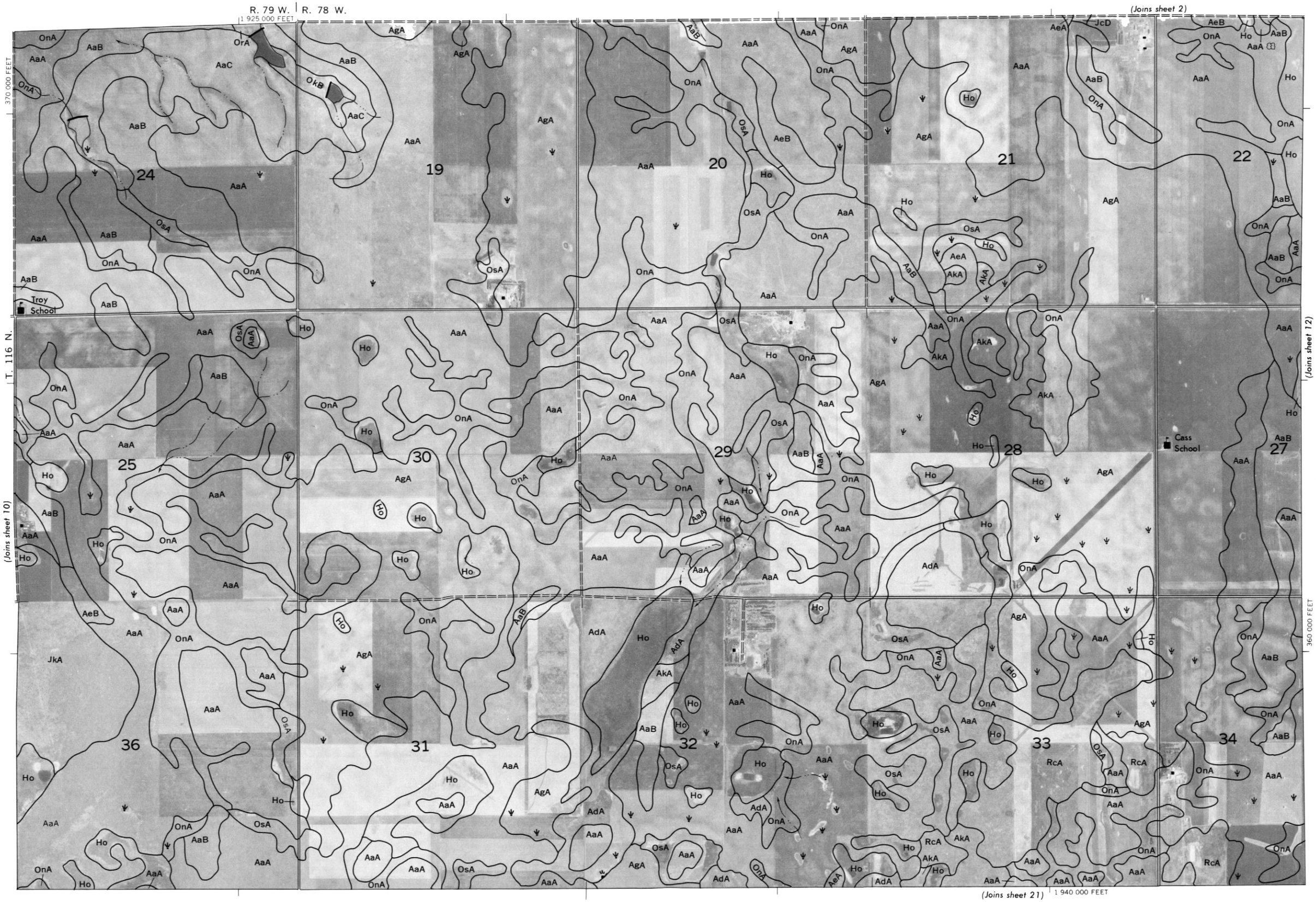
½ 2 000

¾ 3 000

1 4 000

5 000

360 000 FEET


R. 79 W.
R. 78 W.
1 925 000 FEET
370 000 FEET
T. 116 N.
(Joins sheet 10)
(Joins sheet 2)
(Joins sheet 12)
(Joins sheet 21)
1 940 000 FEET
360 000 FEET
Troy School
Cass School
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
OnA
AaA
AaB
AaC
AeA
AeB
AgA
AkA
AdA
Ho
OsA
OrA
OkB
JcD
JkA
RcA
N
1 Mile
5 000 Feet
Scale 1:20 000
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000

N

R. 78 W. | R. 77 W.

(Joins sheet 3)

1 965 000 FEET

370 000 FEET

T. 116 N.

(Joins sheet 11)

(Joins sheet 13)

360 000 FEET

1 945 000 FEET

(Joins sheet 22)

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

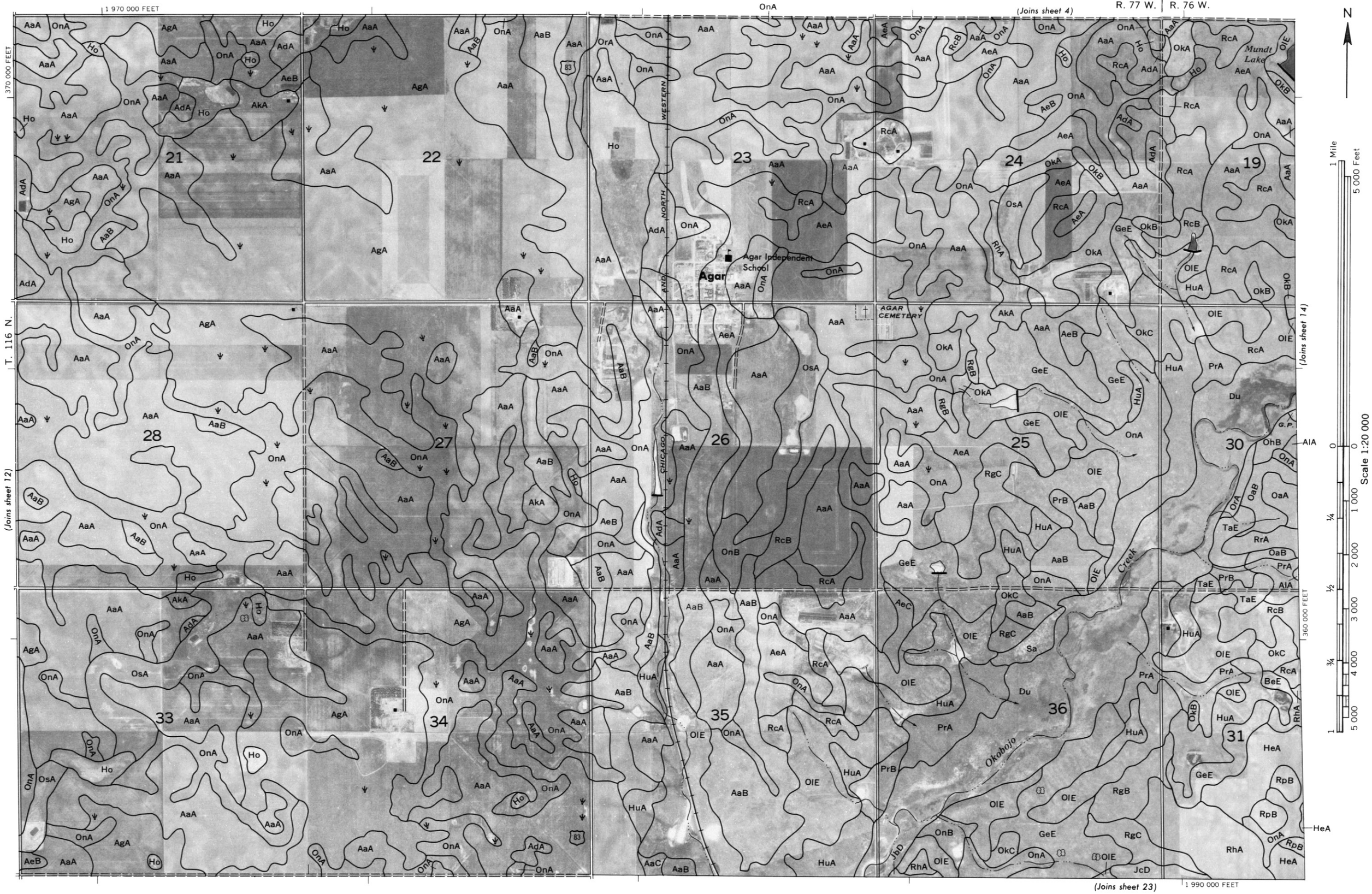
1 4 000 5 000

22 23 24 19 20

27 26 25 30 29

34 35 36 31 32

AaA AaB AdA AeA AeB AgA AkA BeE JgC Ho OnA OsA Ma RcA


1 970 000 FEET
370 000 FEET
T. 116 N.
R. 77 W.
R. 76 W.
(Joins sheet 4)
(Joins sheet 14)
(Joins sheet 12)
(Joins sheet 23)
1 990 000 FEET
360 000 FEET
Agar Independent School
AGAR CEMETERY
Agar
Mundt Lake
Okobojo
Czeek
CHICAGO, NORTH AND WESTERN
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
N
1 Mile
5 000 Feet
Scale 1:20 000
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000

N

(Joins sheet 5)

R. 76 W.

2 015 000 FEET

370 000 FEET

T. 116 N.

1 Mile

5 000 Feet

Scale 1:20 000

(Joins sheet 13)

360 000 FEET

1 995 000 FEET

(Joins sheet 24)

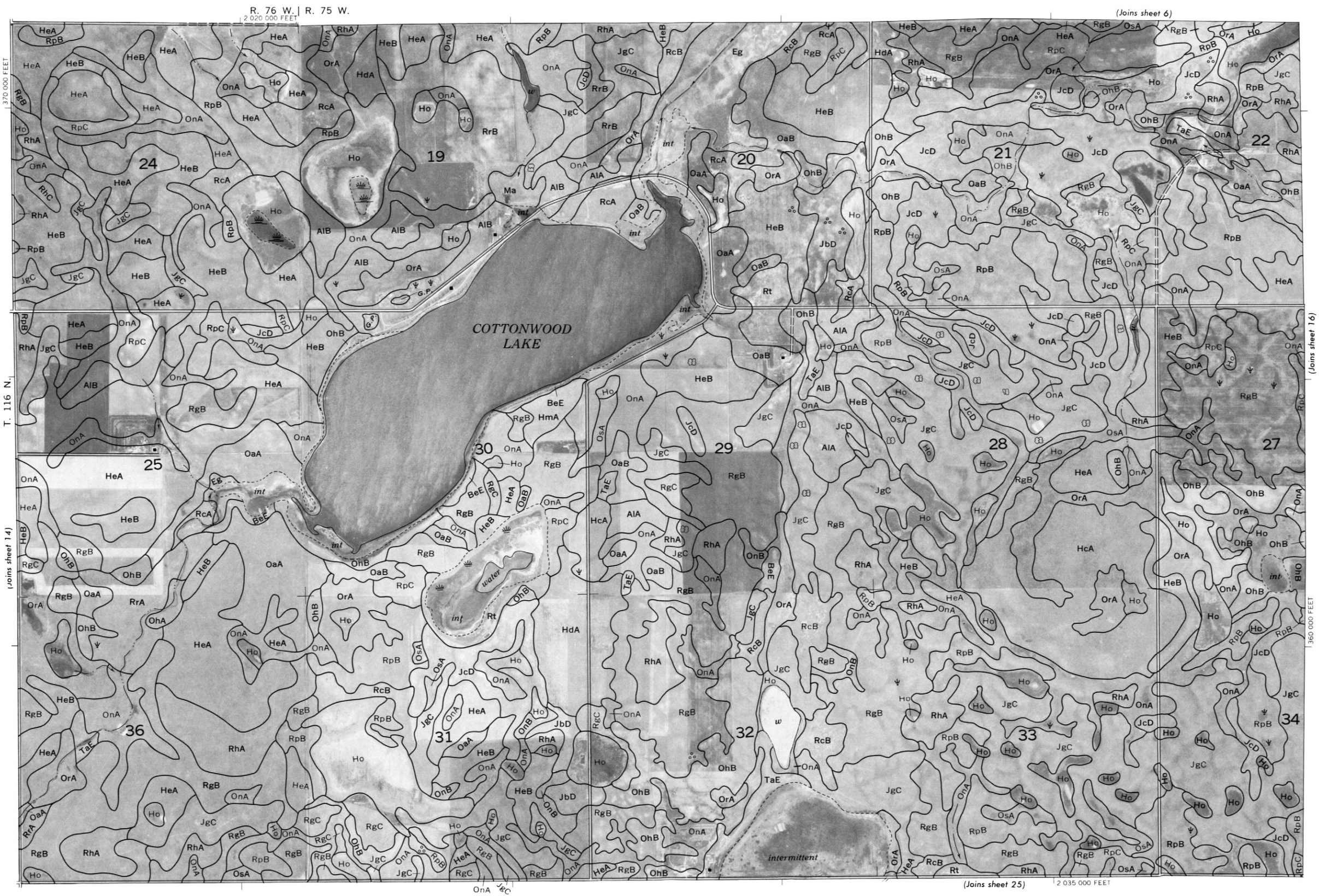
(Joins sheet 15)

Mundt Lake

Okobojo Creek

GRAVEL PIT

19 20 21 22 23 26 27 28 29 30 31 32 33 34 35


R. 76 W.
R. 75 W.
2 020 000 FEET
370 000 FEET
T. 116 N.
(Joins sheet 6)
(Joins sheet 16)
(Joins sheet 14)
(Joins sheet 25)
2 035 000 FEET
360 000 FEET
COTTONWOOD LAKE
water
intermittent
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
N
1 Mile
5 000 Feet
Scale 1:20 000

N

R. 75 W. | R. 74 W.

(Joins sheet 7)

2 060 000 FEET

370 000 FEET

T. 116 N.

(Joins sheet 15)

(Joins sheet 17)

1 Mile

5 000 Feet

Scale 1:20 000

360 000 FEET

2 040 000 FEET

(Joins sheet 26)


2 065 000 FEET
370 000 FEET
R. 74 W.
(Joins sheet 8)
T. 116 N.
(Joins sheet 16)
Cold East School
HYDE COUNTY
360 000 FEET
(Joins sheet 27)
2 085 000 FEET
21
22
23
24
25
26
27
28
33
34
35
36
N
1 Mile
5 000 Feet
Scale 1:20 000

N

1 Mile 5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

(Joins inset B)

1 825 000 FEET

356 000 FEET

358 000 FEET

1 821 000 FEET

LAKE OAHE

FORT SULLY GAME REFUGE

35 36

St Ds

R. 82 W.

(Joins inset A) | (Joins upper left)

2 000 AND 4 000-FOOT GRID TICKS

INSET B

(Joins inset B)

1 825 000 FEET

355 000 FEET

T. 115 N.

(Joins sheet 18)

FORT SULLY GAME REFUGE

LAKE OAHE

1 2 3 10 11 12 13 14 7 17 18

St Ds DoF TaE LoB SuE AaB LoA Sa LoC SwD OtB

(Joins inset A)

1 840 000 FEET

345 000 FEET

340 000 FEET

1 830 000 FEET

R. 82 W. | R. 81 W.

(Joins sheet 28)

1 820 000 FEET

R. 82 W.

INSET A

1 875 000 FEET

355 000 FEET

(Joins sheet 9)

R. 80 W. | R. 79 W.

N

LAKE OAHE

Fuller Lake

Bloody Run

T. 115 N.

1 Mile

5 000 Feet

Scale 1:20 000

(Joins sheet 20)

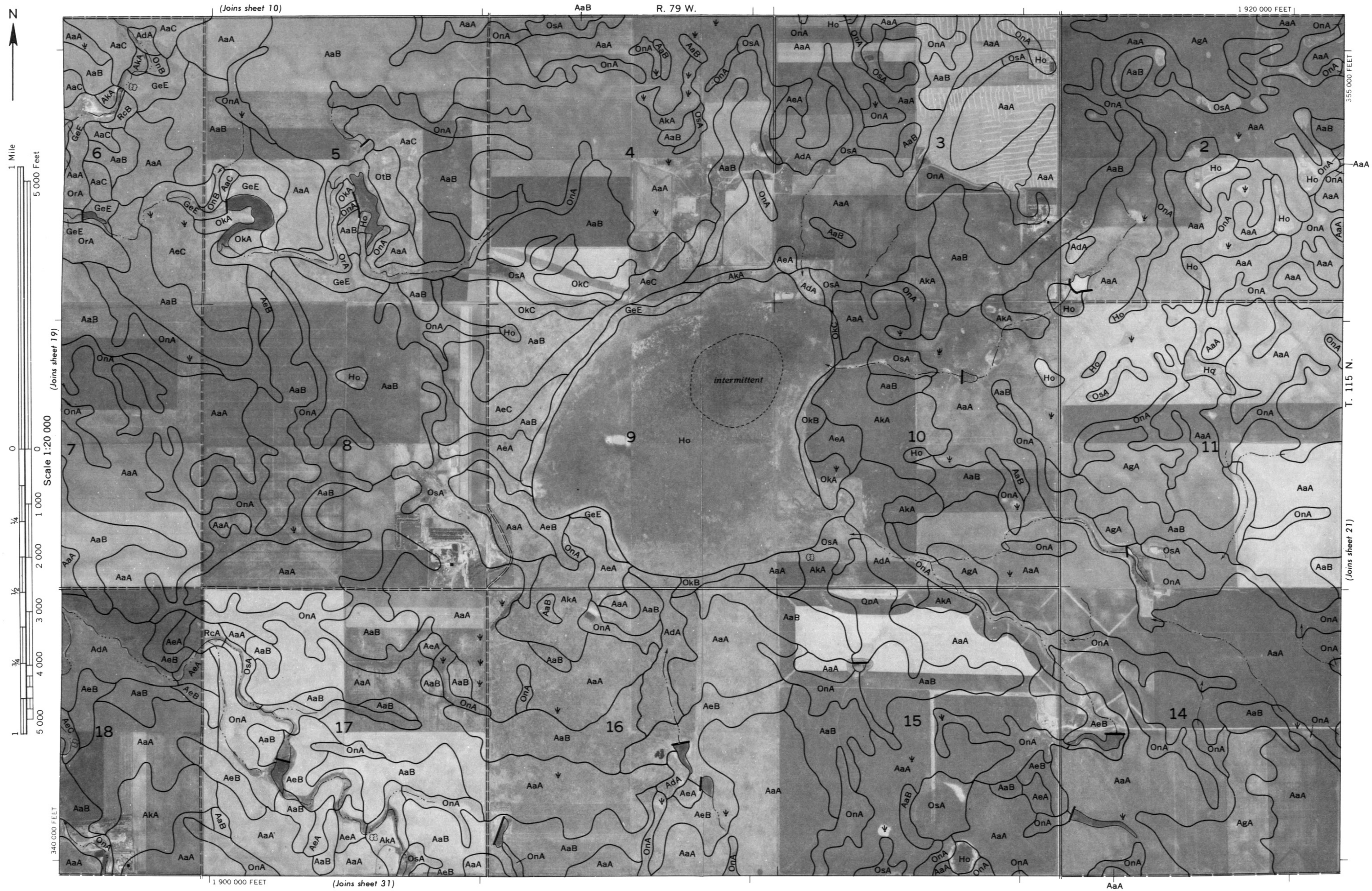
340 000 FEET

(Joins sheet 30)

1 895 000 FEET

(Joins inset sheet 9)

SULLY COUNTY, SOUTH DAKOTA — SHEET NUMBER 20



R. 79 W. | R. 78 W.

1 925 000 FEET

355 000 FEET

T. 115 N.

(Joins sheet 11)

(Joins sheet 22)

(Joins sheet 20)

(Joins sheet 32)

1 940 000 FEET

340 000 FEET

N

1 Mile

5 000 Feet

Scale 1:20 000

1 5 000 | ¾ 4 000 | ½ 3 000 | ¼ 2 000 | 0 1 000 | 0

1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 17 18

AaA AaB AdA AeA AgA AkA JkA OnA OsA RcA Ho

(22)

N

R. 78 W. | R. 77 W.

1 965 000 FEET

355 000 FEET

T. 115 N.

(Joins sheet 12)

(Joins sheet 21)

(Joins sheet 33)

340 000 FEET

1 945 000 FEET

(Joins sheet 33)

1 Mile

5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

1 2 3 5 6 7 8 10 11 12 13 14 15 17 18

1 970 000 FEET

R. 77 W. | R. 76 W.

(Joins sheet 13)

355 000 FEET

T. 115 N.

(Joins sheet 24)

(Joins sheet 22)

(Joins sheet 34)

1 990 000 FEET

340 000 FEET

N

1 Mile

5 000 Feet

Scale 1:20 000

1 5 000 ¾ 4 000 ½ 3 000 ¼ 2 000 0 1 000 0

Creek

Okobojo

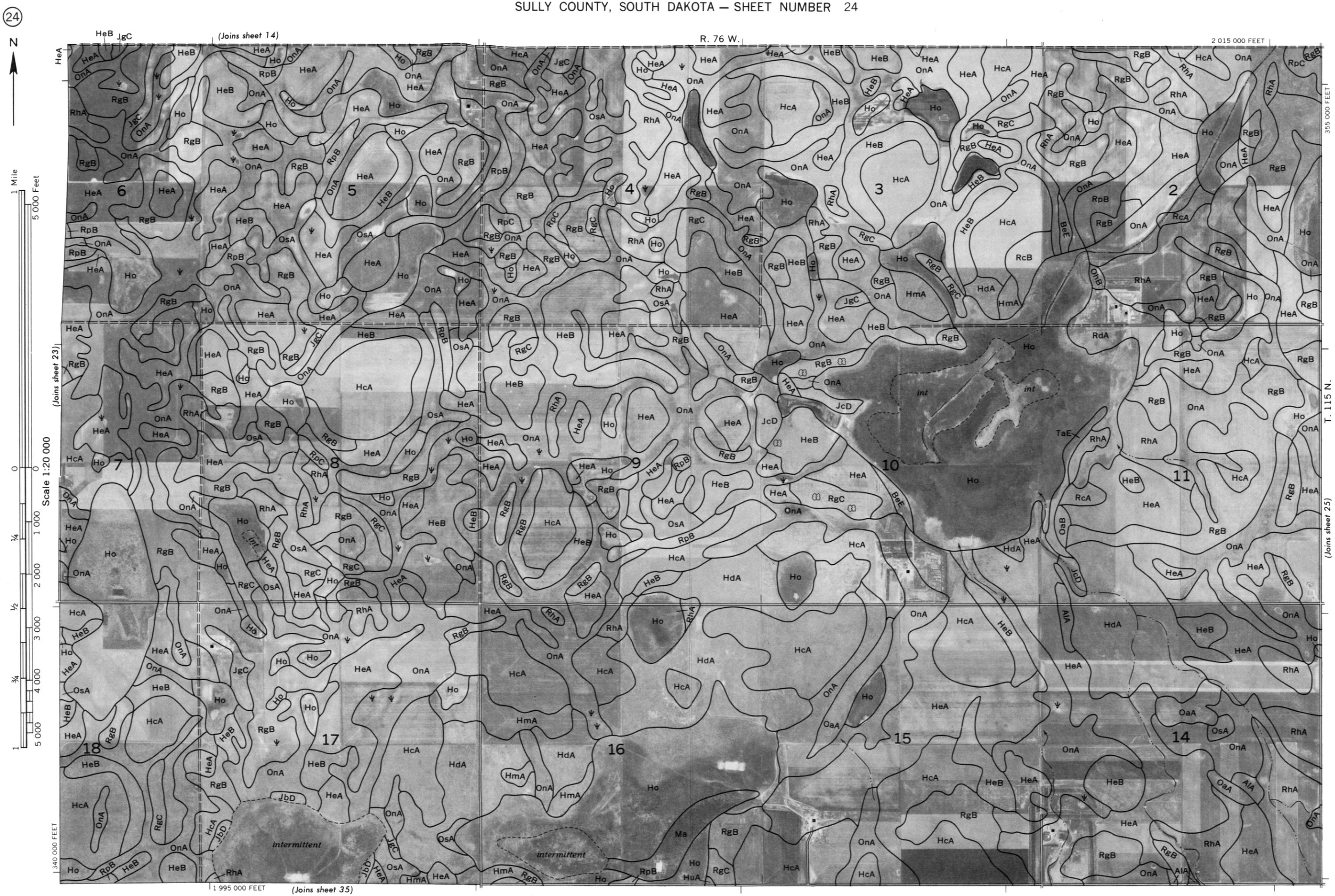
CHICAGO AND NORTH WESTERN

GRAVEL PIT

G.P.

int

HeA


(24)
N
(Joins sheet 14)
R. 76 W.
2 015 000 FEET
355 000 FEET
T. 115 N.
(Joins sheet 25)
(Joins sheet 23)
340 000 FEET
1 995 000 FEET
(Joins sheet 35)
1 Mile
5 000 Feet
Scale 1:20 000
0
¼ 1 000
½ 2 000
¾ 3 000
1 4 000
5 000
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14
intermittent
intermittent

25

R. 76 W. | R. 75 W.

2 020 000 FEET

355 000 FEET

T. 115 N.

(Joins sheet 15)

(Joins sheet 24)

(Joins sheet 26)

(Joins sheet 36)

2 035 000 FEET

340 000 FEET

N

1 Mile

5 000 Feet

Scale 1:20 000

Sully Buttes Rich Valley Attendance Center

RgB

AlA


(Joins sheet 16)
R. 75 W.
R. 74 W.
2 060 000 FEET
355 000 FEET
T. 115 N.
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 37)
2 040 000 FEET
340 000 FEET
N
1 Mile
5 000 Feet
Scale 1:20 000
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18
HeA
HeB
HeC
Ho
RpB
RpC
RgB
RgC
OnA
OsA
JcD
JgC
RhA
RhC
RcA
RcB
AlB

N

1 Mile
5 000 Feet

Scale 1:20 000

(Joins sheet 18) R. 81 W. 1 845 000 FEET

N

1 Mile 5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 4 000 1 5 000

DEWEY CO.

LAKE OAHE

FORT

SULLY

GAME

REFUGE

STANLEY COUNTY

OtB OtC DoF Ds St LoB LoA HuA AaA AaB AeB AeC

19 20 21 27 28 29 33 34

T. 115 N.

335 000 FEET

325 000 FEET

1 830 000 FEET

(Joins sheet 29)

(Joins sheet 39)

1 850 000 FEET

(Joins inset sheet 9)

DEWEY COUNTY

LAKE OAHE

355 000 FEET

T. 115 N.

(Joins sheet 28)

FORT SULLY GAME REFUGE

(Joins sheet 30)

325 000 FEET

R. 81 W. | R. 80 W.

(Joins sheet 40)

1 870 000 FEET

N

1 Mile

5 000 Feet

Scale 1:20 000

0 1/4 1/2 3/4 1

0 1 000 2 000 3 000 4 000 5 000

N

(Joins sheet 19)

R. 80 W. | R. 79 W.

1 895 000 FEET

T. 115 N.

335 000 FEET

325 000 FEET

(Joins sheet 29)

(Joins sheet 31)

1 875 000 FEET

(Joins sheet 41)

Scale 1:20 000

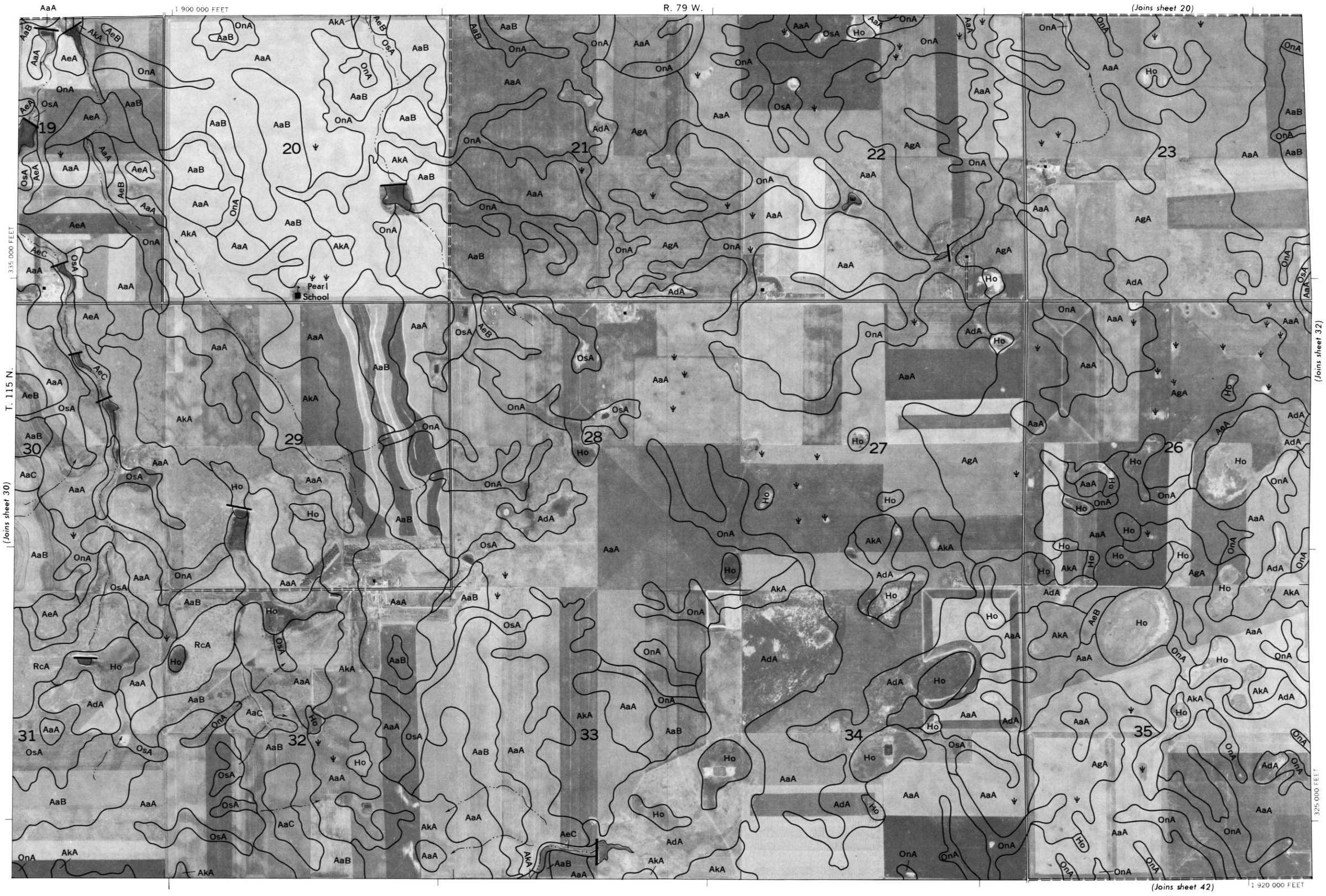
1 Mile

5 000 Feet

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

Bloody Run

21 22 23 24 19 28 27 26 25 30 33 34 35 36 31


AaA
1 900 000 FEET
R. 79 W.
(Joins sheet 20)
N
335 000 FEET
T. 115 N.
19
20
21
22
23
Pearl School
(Joins sheet 32)
(Joins sheet 30)
29
28
27
26
30
31
32
33
34
35
325 000 FEET
(Joins sheet 42)
1 920 000 FEET
1 Mile
5 000 Feet
Scale 1:20 000

(32)

N

(Joins sheet 21) R. 79 W. | R. 78 W. 1 940 000 FEET

T. 115 N.

335 000 FEET

(Joins sheet 33)

(Joins sheet 31)

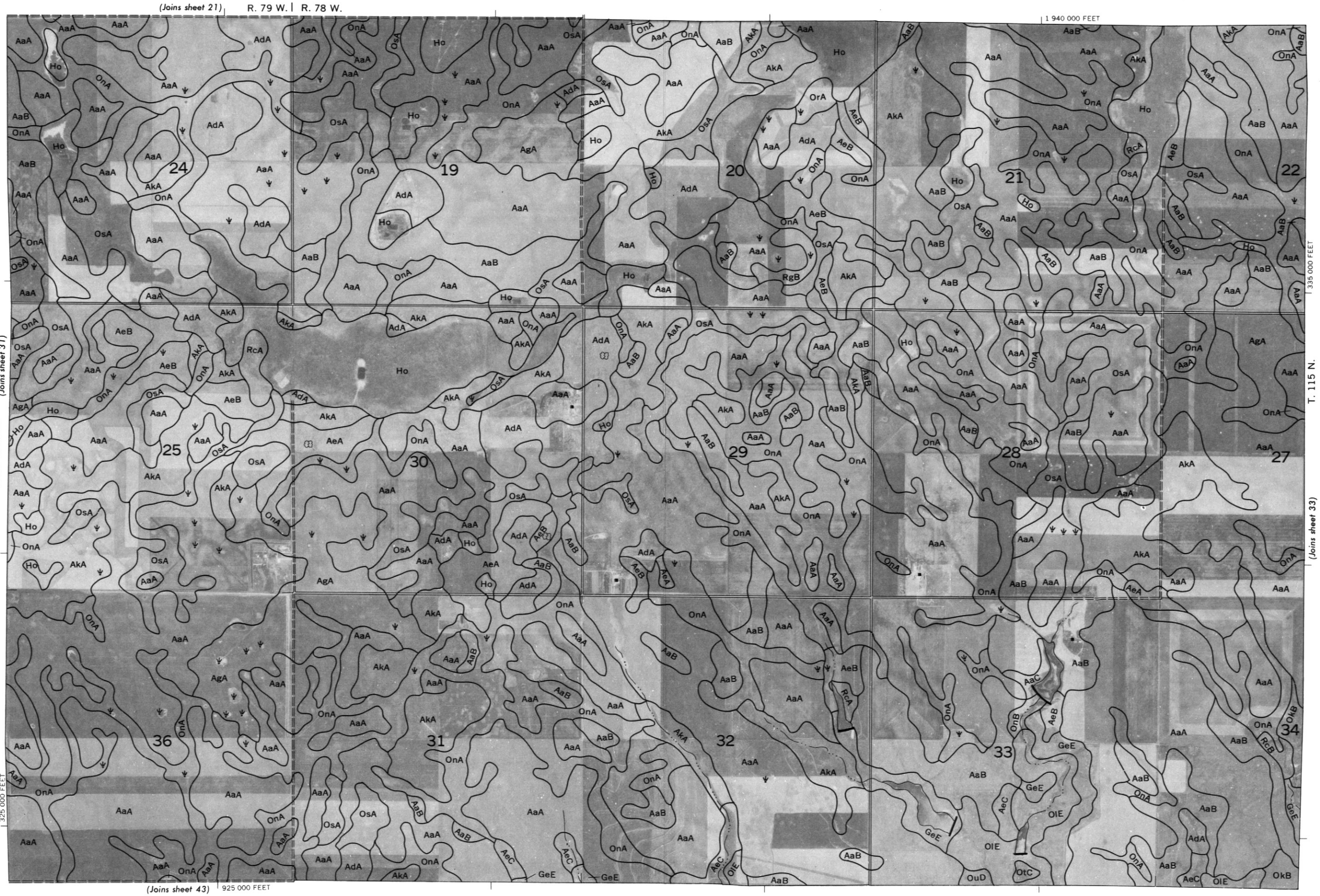
325 000 FEET

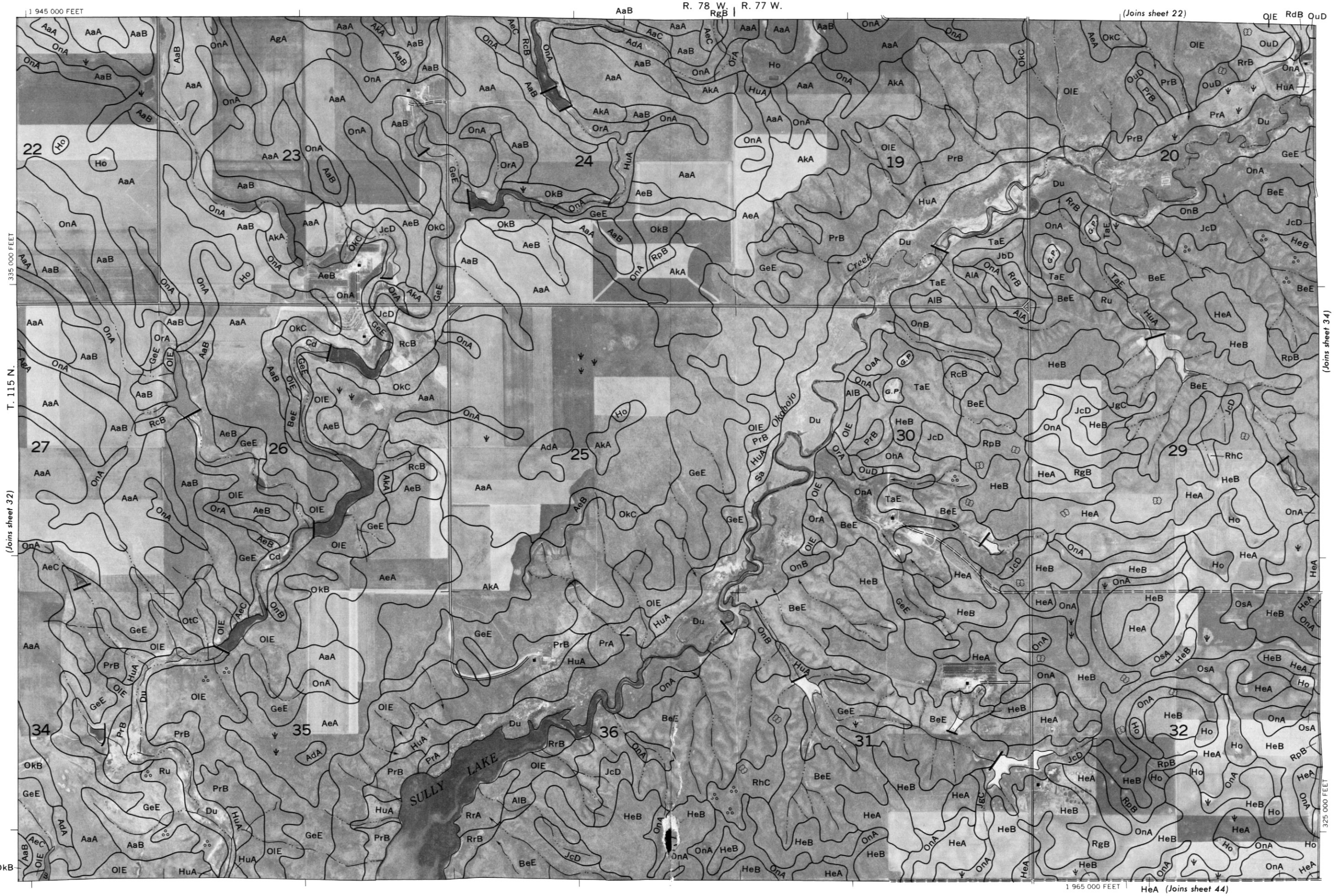
(Joins sheet 43) 925 000 FEET

1 Mile 5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000




1 945 000 FEET
R. 78 W.
R. 77 W.
(Joins sheet 22)
335 000 FEET
T. 115 N.
(Joins sheet 32)
(Joins sheet 34)
325 000 FEET
1 965 000 FEET
HeA (Joins sheet 44)
SULLY LAKE
Okobojo Creek
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
N
1 Mile
5 000 Feet
Scale 1:20 000

N

R. 77 W. | R. 76 W.

1 990 000 FEET

335 000 FEET

T. 115 N.

(Joins sheet 23)

(Joins sheet 33)

(Joins sheet 35)

(Joins sheet 45)

1 970 000 FEET

325 000 FEET

OsA

RgB

RhA

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

N

R. 76 W.

T. 115 N.

1 995 000 FEET

2 015 000 FEET

335 000 FEET

325 000 FEET

(Joins sheet 24)

(Joins sheet 36)

(Joins sheet 36)

(Joins sheet 46)

1 Mile

5 000 Feet

Scale 1:20 000

0 1/4 1/2 3/4 1

0 1 000 2 000 3 000 4 000 5 000

(36)

N

(Joins sheet 25) R. 76 W. | R. 75 W.

2 035 000 FEET

OsA

1 Mile

5 000 Feet

(Joins sheet 35)

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

325 000 FEET

335 000 FEET

T. 115 N.

(Joins sheet 37)

(Joins sheet 47) 2 020 000 FEET

R. 75 W. | R. 74 W.

2 040 000 FEET

(Joins sheet 26)

335 000 FEET

T. 115 N.

(Joins sheet 36)

(Joins sheet 38)

325 000 FEET

2 060 000 FEET

(Joins sheet 48)

N

1 Mile

5 000 Feet

Scale 1:20 000

1 0 5 000 | ¾ 4 000 | ½ 3 000 | ¼ 2 000 | 0 0 1 000

N

(Joins sheet 27)

R. 74 W.

2 085 000 FEET

335 000 FEET

T. 115 N.

HYDE COUNTY

1 Mile

5 000 Feet

0

(Joins sheet 37)

Scale 1:20 000

0 1/4 1 000 1/2 2 000 3/4 3 000 1 4 000 5 000

325 000 FEET

2 065 000 FEET

(Joins sheet 49)

21 22 23 24 25 26 27 28 33 34 35 36

Knoll

Creek

Medicine

Rt

int

G.P.

N

1 840 000 FEET

R. 81 W.

(Joins sheet 39)

305 000 FEET

STANLEY COUNTY

T. 114 N.

(Joins sheet 50)

295 000 FEET

LAKE OAHE

(Joins sheet 60)

1 845 000 FEET

1 840 000 FEET

R. 81 W.

(Joins sheet 28)

320 000 FEET

LAKE OAHE

STANLEY COUNTY

T. 114 N.

(Joins sheet 40)

310 000 FEET

1 845 000 FEET

(Joins inset, sheet 39)

1 Mile

5 000 Feet

Scale 1:20 000

(40)

N

R. 81 W. | R. 80 W.

(Joins sheet 29)

(Joins sheet 39)

(Joins sheet 41)

(Joins sheet 50)

1 870 000 FEET

320 000 FEET

310 000 FEET

1 850 000 FEET

T. 114 N.

1 Mile

5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

SULLY BUTTES

1 875 000 FEET

(Joins sheet 30)

R. 80 W. | R. 79 W.

N

320 000 FEET

T. 114 N.

(Joins sheet 40)

(Joins sheet 42)

SULLY

BUTTES

1 Mile

5 000 Feet

Scale 1:20 000

310 000 FEET

(Joins sheet 51)

1 895 000 FEET

(42)

(Joins sheet 31)

R. 79 W.

1 920 000 FEET

320 000 FEET

T. 114 N.

(Joins sheet 41)

(Joins sheet 43)

N

1 Mile

5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

310 000 FEET

1 900 000 FEET

(Joins sheet 52)

R. 79 W. | R. 78 W.

1 925 000 FEET

(Joins sheet 32)

320 000 FEET

T. 114 N.

(Joins sheet 42)

(Joins sheet 44)

1 940 000 FEET

(Joins sheet 53)

310 000 FEET

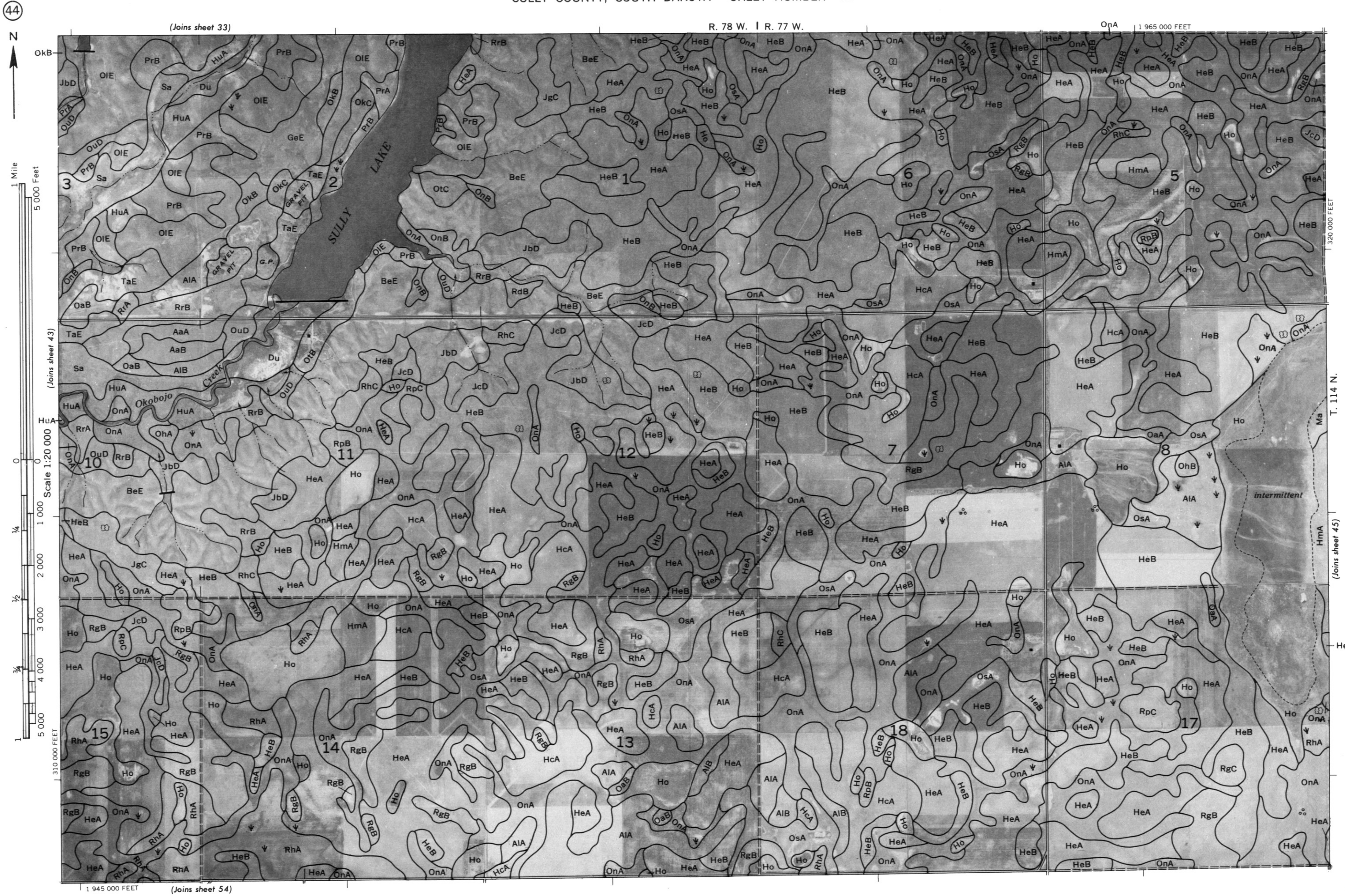
N

1 Mile

5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 2 000 ½ 3 000 ¾ 4 000 1 5 000


44
N
(Joins sheet 33)
R. 78 W.
R. 77 W.
1 965 000 FEET
320 000 FEET
T. 114 N.
(Joins sheet 45)
(Joins sheet 43)
(Joins sheet 54)
1 945 000 FEET
310 000 FEET
1 Mile
5 000 Feet
Scale 1:20 000
SULLY LAKE
Okobojo Creek
GRAVEL PIT
G.P.
intermittent
OkB
HuA
HeA
OnA
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18

N

1 970 000 FEET

R. 77 W.
(Joins sheet 34)

R. 76 W.

320 000 FEET

T. 114 N.

(Joins sheet 44)

(Joins sheet 46)

310 000 FEET

(Joins sheet 55)

1 990 000 FEET

ONIDA
(county seat)

SEWAGE DISPOSAL POND

intermittent

Sully Buttes Onida Attendance Center

CHICAGO AND NORTH WESTERN

1 Mile
5 000 Feet
Scale 1:20 000
0 0
¼ 1 000
½ 2 000
¾ 3 000
1 4 000
5 000

N

R. 76 W.

T. 114 N.

(Joins sheet 35)

(Joins sheet 45)

(Joins sheet 47)

(Joins sheet 56)

2 015 000 FEET

320 000 FEET

1 995 000 FEET

310 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

Sully Buttes Blaine Attendance Center

R. 76 W. | R. 75 W.

2 020 000 FEET

(Joins sheet 36)

320 000 FEET

T. 114 N.

(Joins sheet 46)

(Joins sheet 48)

310 000 FEET

2 035 000 FEET

(Joins sheet 57)

Buffalo District 13 School

N

1 Mile

5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

N

R. 75 W. | R. 74 W.

2 060 000 FEET

320 000 FEET

T. 114 N.

(Joins sheet 37)

(Joins sheet 47)

(Joins sheet 49)

(Joins sheet 58)

2 040 000 FEET

310 000 FEET

1 Mile 5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

Medicine Knoll Creek

Knoll Creek

Lake Durrstein

GRAVEL PIT G.P.

2 065 000 FEET

R. 74 W.

(Joins sheet 38)

320 000 FEET

T. 114 N.

(Joins sheet 48)

HYDE COUNTY

310 000 FEET

(Joins sheet 59)

2 085 000 FEET

N

1 Mile

5 000 Feet

Scale 1:20 000

0 1 000 2 000 3 000 4 000 5 000

¼ ½ ¾ 1

(50)

N

R. 81 W. | R. 80 W.

1 870 000 FEET

305 000 FEET

T. 114 N.

(Joins sheet 40)

(Joins inset, sheet 39)

(Joins sheet 51)

(Joins sheet 61)

1 850 000 FEET

1 Mile

5 000 Feet

295 000 FEET

22 23 24 19 20

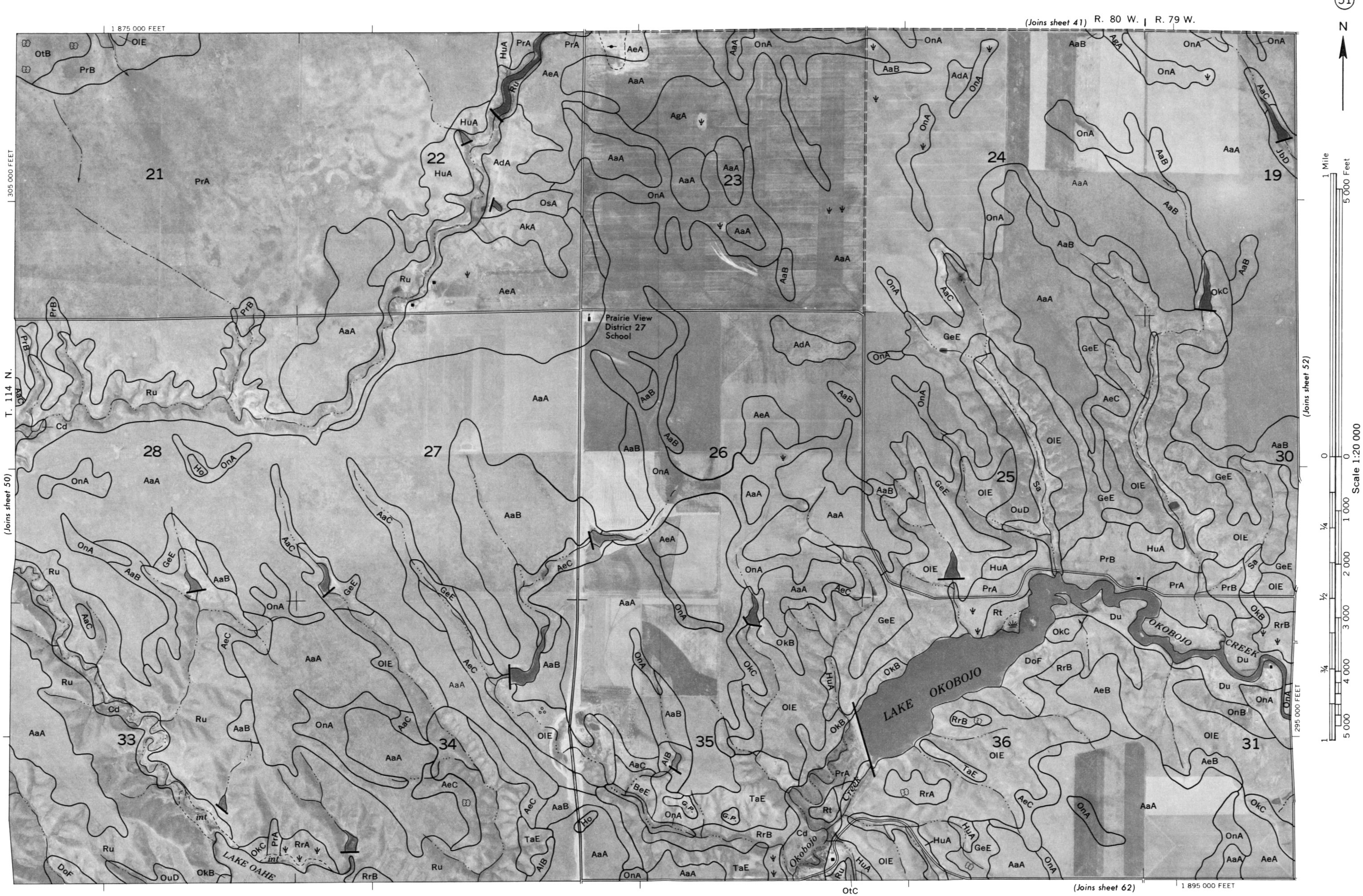
27 26 25 30 29

34 35 36 31 32

LoC LoB LoA SuE AaA AaB AaC AgA AkA OnA Ho HuA PrA PrB OtB OtC DoF Ru SwD GeE OnB JbD LoD AeB AeC OsA RcA Cd

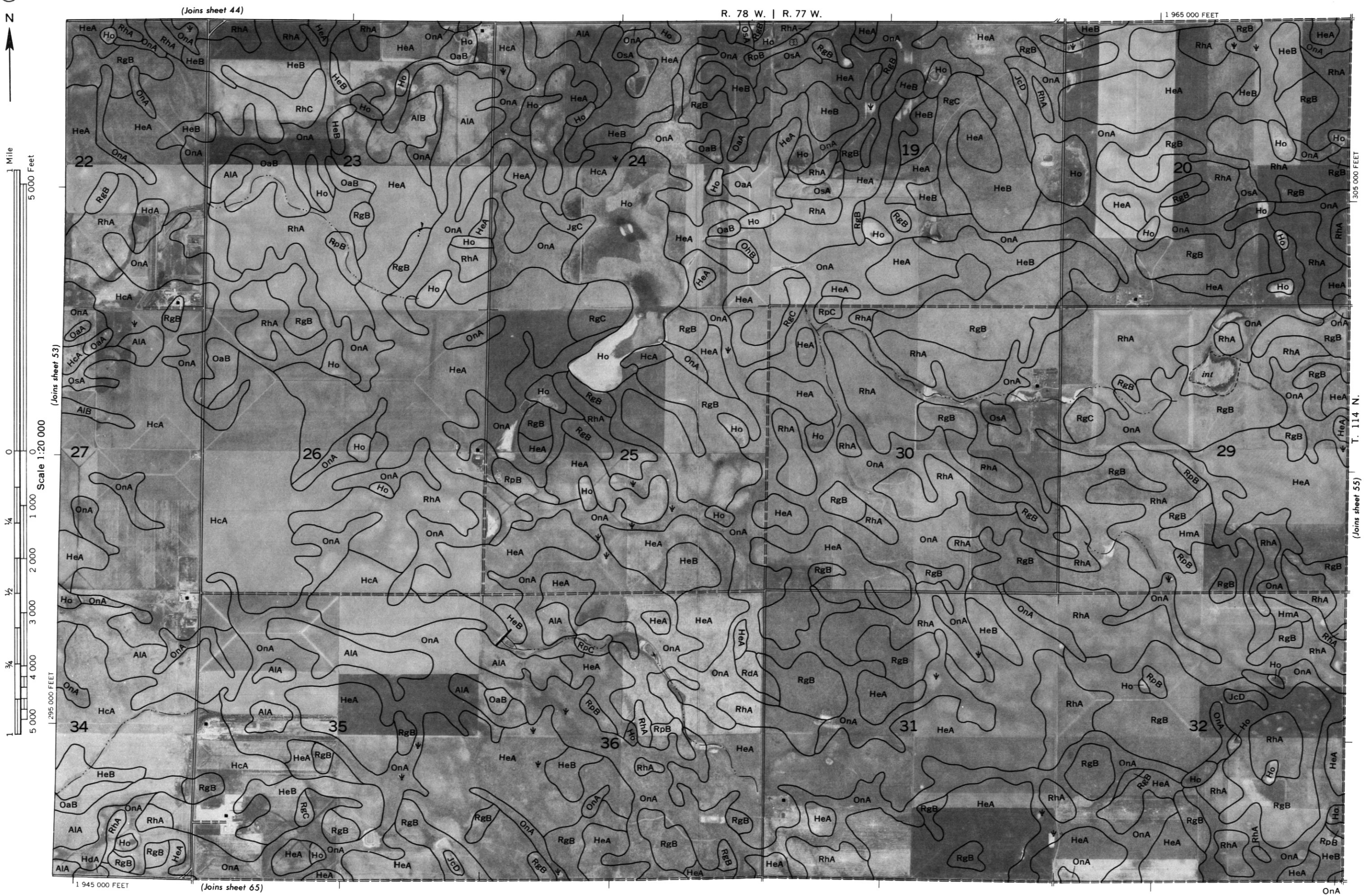
Creek

int


51
N
(Joins sheet 41)
R. 80 W.
R. 79 W.
1 875 000 FEET
305 000 FEET
T. 114 N.
(Joins sheet 50)
(Joins sheet 52)
(Joins sheet 62)
295 000 FEET
1 895 000 FEET
Prairie View
District 27
School
LAKE OKOBOJO
OKOBOJO CREEK
Okobojo Creek
LAKE OAHE
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
1 Mile
5 000 Feet
Scale 1:20 000
0
¼
½
¾
1
0
1 000
2 000
3 000
4 000
5 000


N
(Joins sheet 42)
R. 79 W.
1 920 000 FEET
305 000 FEET
T. 114 N.
(Joins sheet 53)
(Joins sheet 51)
1 Mile
5 000 Feet
Scale 1:20 000
1 000
2 000
3 000
4 000
5 000
295 000 FEET
1 900 000 FEET
(Joins sheet 63)
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
OKOBOJO CEMETERY
Okobojo
Okobojo Creek
int
OnA
AaA
AaB
AaC
AeA
AeB
AeC
AgA
AkA
AlA
AlB
BeE
Du
GeE
HoA
HuA
JbD
OkA
OkB
OkC
OuD
PrA
PrB
RcA
RcB
RgB
RrA
RrB
Ru
Sa
TaE


1 925 000 FEET
R. 79 W. | R. 78 W.
(Joins sheet 43)
N
T. 114 N.
305 000 FEET
(Joins sheet 52)
(Joins sheet 54)
(Joins sheet 64)
1 940 000 FEET
295 000 FEET
Okobojo
Creek
1 Mile
5 000 Feet
Scale 1:20 000


(Joins sheet 44)
R. 78 W. | R. 77 W.
1 965 000 FEET
N
1 Mile
5 000 Feet
Scale 1:20 000
(Joins sheet 53)
295 000 FEET
305 000 FEET
T. 114 N.
(Joins sheet 55)
1 945 000 FEET
(Joins sheet 65)
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
int
HeA
HeB
RhA
RhC
AlA
AlB
OaB
OaA
OnA
Ho
RgB
RgC
RpB
RpC
HdA
HcA
JgC
OsA
OhB
RdA
JcD
HmA
RfC

55

HeA | 1 970 000 FEET | (Joins sheet 45) | R. 77 W. | R. 76 W.

305 000 FEET

T. 114 N.

(Joins sheet 54)

(Joins sheet 56)

295 000 FEET

(Joins sheet 66) | 1 990 000 FEET

N

Scale 1:20 000

1 Mile | 5 000 Feet

0 | 0

¼ | 1 000

½ | 2 000

¾ | 3 000

1 | 4 000 | 5 000

CHICAGO AND NORTH WESTERN

83

N

R. 76 W.

2 015 000 FEET

305 000 FEET

T. 114 N.

(Joins sheet 46)

(Joins sheet 55)

(Joins sheet 57)

(Joins sheet 67)

1 995 000 FEET

295 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

19 20 21 22 23

30 29 28 27 26

31 32 33 34 35

N

2 020 000 FEET | R. 76 W. | R. 75 W.

(Joins sheet 47)

305 000 FEET

T. 114 N.

(Joins sheet 56)

(Joins sheet 58)

295 000 FEET

2 035 000 FEET

(Joins sheet 68)

1 Mile

5 000 Feet

Scale 1:20 000

1/4 1/2 3/4 1

N

R. 75 W. | R. 74 W.

(Joins sheet 48)

2 060 000 FEET

305 000 FEET

T. 114 N.

1 Mile

5 000 Feet

Scale 1:20 000

(Joins sheet 57)

(Joins sheet 59)

295 000 FEET

2 040 000 FEET

(Joins sheet 69)

Creek

Knoll

Medicine

int

22 23 24 19 20

27 26 25 30 29

34 35 36 31 32

59

N

2 065 000 FEET

R. 74 W.

(Joins sheet 49)

305 000 FEET

T. 114 N.

(Joins sheet 58)

HYDE COUNTY

(Joins sheet 70)

2 085 000 FEET

295 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

N

1 Mile

5 000 Feet

Scale 1:20 000

(Joins inset, sheet 39)

1 845 000 FEET

R. 81 W.

290 000 FEET

T. 113 N.

(Joins sheet 61)

280 000 FEET

1 830 000 FEET

(Joins inset, sheet 71)

STANLEY COUNTY

LAKE OAHE

5 4 3 8 9 10 17 16 15 1

Ru TaE DoF HuA SuE LoA LoB OnA LoC LoD Sa PrB AaB AaC HuA AeB AeC OtC JbD SwD BeE AaA

Creek Sully

N

1 850 000 FEET

R. 81 W. | R. 80 W.

(Joins sheet 50)

290 000 FEET

T. 113 N.

(Joins sheet 60)

(Joins sheet 62)

280 000 FEET

(Joins sheet 71)

1 870 000 FEET

LAKE OAHE

Sully Creek

Sully Creek

Plum Creek

1 Mile

5 000 Feet

Scale 1:20 000


N
(Joins sheet 51)
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 72)
R. 80 W. | R. 79 W.
T. 113 N.
1 895 000 FEET
290 000 FEET
280 000 FEET
1 875 000 FEET
1 Mile
5 000 Feet
Scale 1:20 000
LAKE OAHE
Okobojo
Creek

63

N

R. 79 W.

1 900 000 FEET

290 000 FEET

T. 113 N.

(Joins sheet 52)

(Joins sheet 64)

(Joins sheet 62)

(Joins sheet 73)

1 920 000 FEET

280 000 FEET

AgA

1 Mile

5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

N

(Joins sheet 53) R. 79 W. | R. 78 W.

1 940 000 FEET

290 000 FEET

T. 113 N.

(Joins sheet 65)

(Joins sheet 63)

Scale 1:20 000

1 Mile

5 000 Feet

280 000 FEET

(Joins sheet 74) 1 925 000 FEET

Warnes Slough

65

N

1 945 000 FEET

R. 78 W. | R. 77 W.

(Joins sheet 54)

290 000 FEET

T. 113 N.

(Joins sheet 64)

(Joins sheet 66)

280 000 FEET

(Joins sheet 75)

1 965 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

N

R. 77 W. | R. 76 W.

1 990 000 FEET

290 000 FEET

(Joins sheet 55)

(Joins sheet 65)

(Joins sheet 67)

(Joins sheet 76)

1 970 000 FEET

280 000 FEET

T. 113 N.

Eakin

WESTERN AND CHICAGO

1 Mile

5 000 Feet

Scale 1:20 000

1 0 ¼ 0 ½ 1 000 ¾ 2 000 1 3 000 1¼ 4 000 1½ 5 000

1 995 000 FEET

R. 76 W.

(Joins sheet 56)

290 000 FEET

T. 113 N.

(Joins sheet 66)

(Joins sheet 68)

280 000 FEET

(Joins sheet 77)

2 015 000 FEET

N

1 Mile

5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

N

(Joins sheet 57) R. 76 W. | R. 75 W. 2 035 000 FEET

290 000 FEET

T. 113 N.

(Joins sheet 67)

(Joins sheet 69)

280 000 FEET

(Joins sheet 78) 2 020 000 FEET

Post Lake

Medicine Knoll Creek

1 Mile

5 000 Feet

Scale 1:20 000

0 0 1/4 1 000 1/2 2 000 3/4 3 000 1 4 000 5 000

2 040 000 FEET

R. 75 W. | R. 74 W.

(Joins sheet 58)

290 000 FEET

T. 113 N.

(Joins sheet 68)

(Joins sheet 70)

280 000 FEET

(Joins sheet 79)

2 060 000 FEET

N

1 Mile

5 000 Feet

Scale 1:20 000

Creek

Knoll

Medicine

int

N

(Joins sheet 59)

R. 74 W.

2 085 000 FEET

290 000 FEET

T. 113 N.

HYDE COUNTY

Walker Lake

1 Mile

5 000 Feet

Scale 1:20 000

(Joins sheet 69)

280 000 FEET

2 065 000 FEET

(Joins sheet 80)

N

1 855 000 FEET

R. 81 W. | R. 80 W.

(Joins sheet 61)

275 000 FEET

(Joins inset, sheet 71)

T. 113 N.

(Joins sheet 72)

22 23 24 25 19 20 30 29 32

AaB LoB OnA LoC Ru DoF Sa AaA BeE OtC Ds Co LoA SuE TaE SwD RrB OlE OkA OkC GeE OnB LoD AeA JbD Ho

LAKE OAHE

STANLEY COUNTY

HUGHES COUNTY

1 870 000 FEET

1 Mile

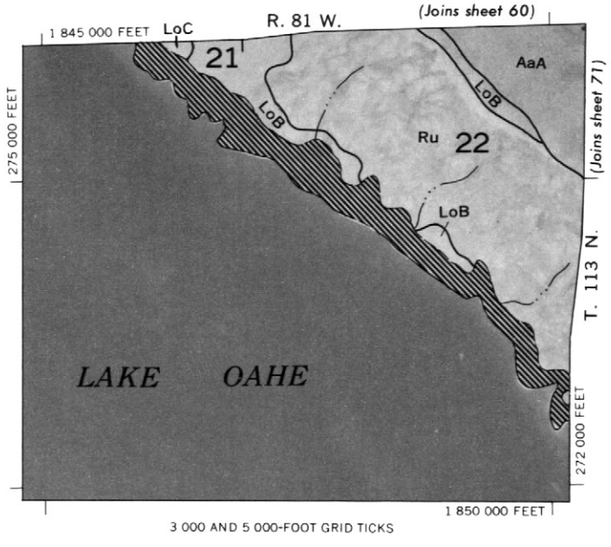
5 000 Feet

Scale 1:20 000

0 5 000 1 000 2 000 3 000 4 000

1/4 1/2 3/4 1

265 000 FEET



3 000 AND 5 000-FOOT GRID TICKS

N

(Joins sheet 62)

R. 80 W. | R. 79 W.

1 895 000 FEET

275 000 FEET

T. 113 N.

(Joins sheet 71)

(Joins sheet 73)

1 Mile

5 000 Feet

Scale 1:20 000

0 0 1/4 1 000 1/2 2 000 3/4 3 000 1 4 000 5 000

265 000 FEET

1 875 000 FEET

LAKE OAHE

LAKE OAHE

21 22 23 24 19

28 27 26 25 30

33 34 35 36 31

HUGHES COUNTY

1 900 000 FEET

R. 79 W.

(Joins sheet 63)

275 000 FEET

T. 113 N.

(Joins sheet 72)

(Joins sheet 74)

265 000 FEET

1 920 000 FEET

HUGHES COUNTY

N

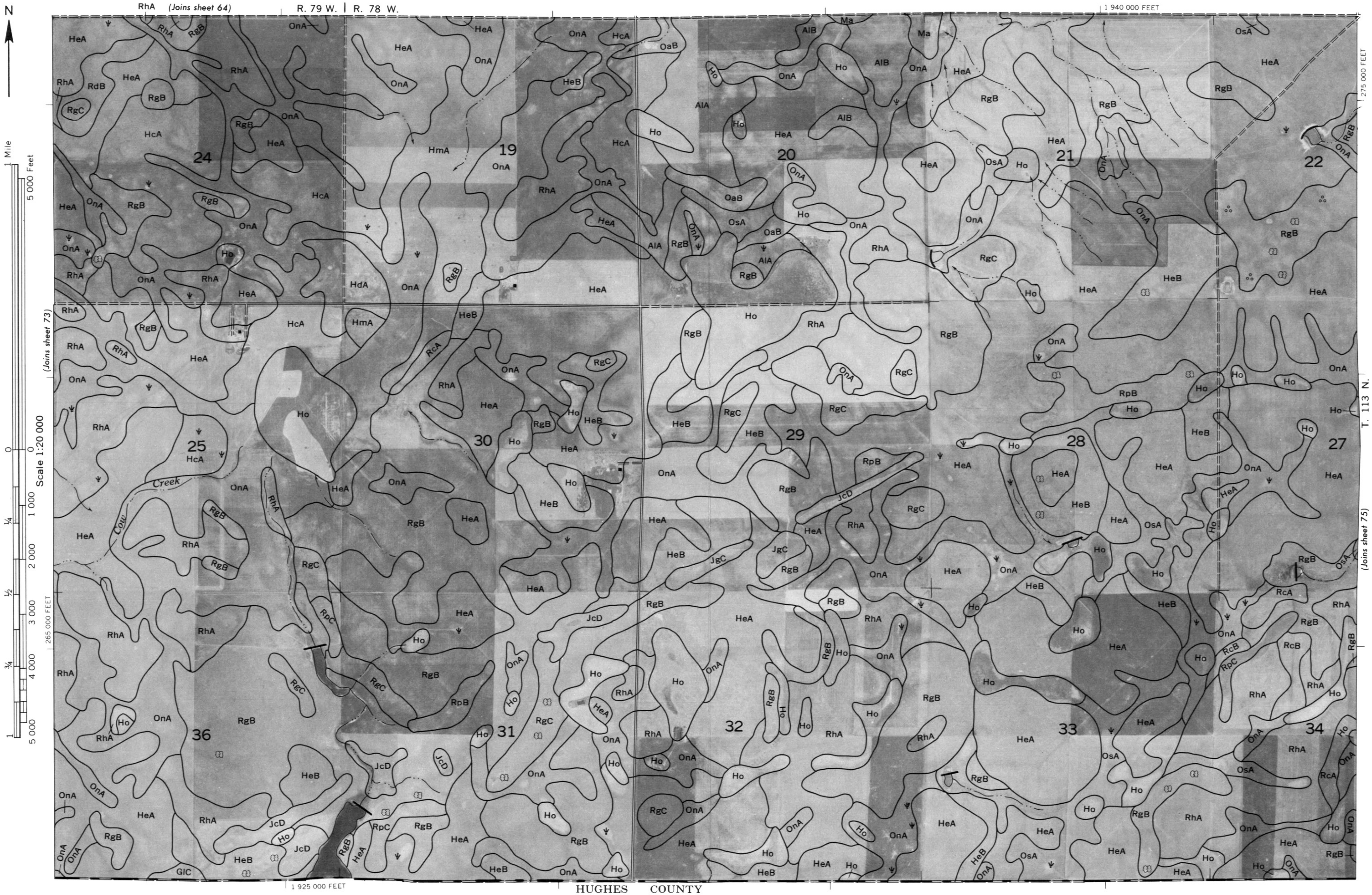
1 Mile

5 000 Feet

Scale 1:20 000

0 1 000 2 000 3 000 4 000 5 000

¼ ½ ¾ 1


N
(Joins sheet 64)
R. 79 W.
R. 78 W.
1 940 000 FEET
275 000 FEET
(Joins sheet 73)
T. 113 N.
(Joins sheet 75)
265 000 FEET
1 925 000 FEET
HUGHES COUNTY
Scale 1:20 000
1 Mile
5 000 Feet
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34
Cow Creek

N

R. 78 W. | R. 77 W.

1 945 000 FEET

1 965 000 FEET

275 000 FEET

265 000 FEET

T. 113 N.

(Joins sheet 65)

(Joins sheet 76)

(Joins sheet 74)

HUGHES COUNTY

1 Mile

5 000 Feet

Scale 1:20 000

0 1/4 1/2 3/4 1

0 1 000 2 000 3 000 4 000 5 000

N

R. 77 W. | R. 76 W.

1 990 000 FEET

275 000 FEET

(Joins sheet 66)

(Joins sheet 75)

(Joins sheet 77)

T. 113 N.

1 Mile

5 000 Feet

Scale 1:20 000

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

265 000 FEET

1 970 000 FEET

HUGHES COUNTY

NORTH WESTERN AND CHICAGO

21 22 23 24 19

28 27 26 25 30

33 34 35 36 31

1 995 000 FEET

R. 76 W.

(Joins sheet 67)

275 000 FEET

T. 113 N.

(Joins sheet 76)

(Joins sheet 78)

265 000 FEET

2 015 000 FEET

HUGHES COUNTY

N

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

N

(Joins sheet 68)

R. 76 W.

R. 75 W.

2 035 000 FEET

275 000 FEET

T. 113 N.

(Joins sheet 77)

(Joins sheet 79)

265 000 FEET

2 020 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

1 000 0 1 000 2 000 3 000 4 000 5 000

¼ ½ ¾ 1

Creek

Knoll

Medicine

GRAVEL PIT

G.P.

HUGHES COUNTY

79

2 040 000 FEET

R. 75 W. | R. 74 W.

(Joins sheet 69)

275 000 FEET

T. 113 N.

(Joins sheet 78)

(Joins sheet 80)

265 000 FEET

2 060 000 FEET

N

1 Mile

5 000 Feet

Scale 1:20 000

1 5 000 | ¾ 4 000 | ½ 2 000 | ¼ 1 000 | 0 0

HUGHES COUNTY

(80)

N

(Joins sheet 70)

GIB

R. 74 W.

2 085 000 FEET

2 075 000 FEET

T. 113 N.

(Joins sheet 79)

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

265 000 FEET

21 22 23 24

28 27 26 25

33 34 35 36

2 065 000 FEET

HUGHES COUNTY

HYDE COUNTY